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# Radio-Electronics

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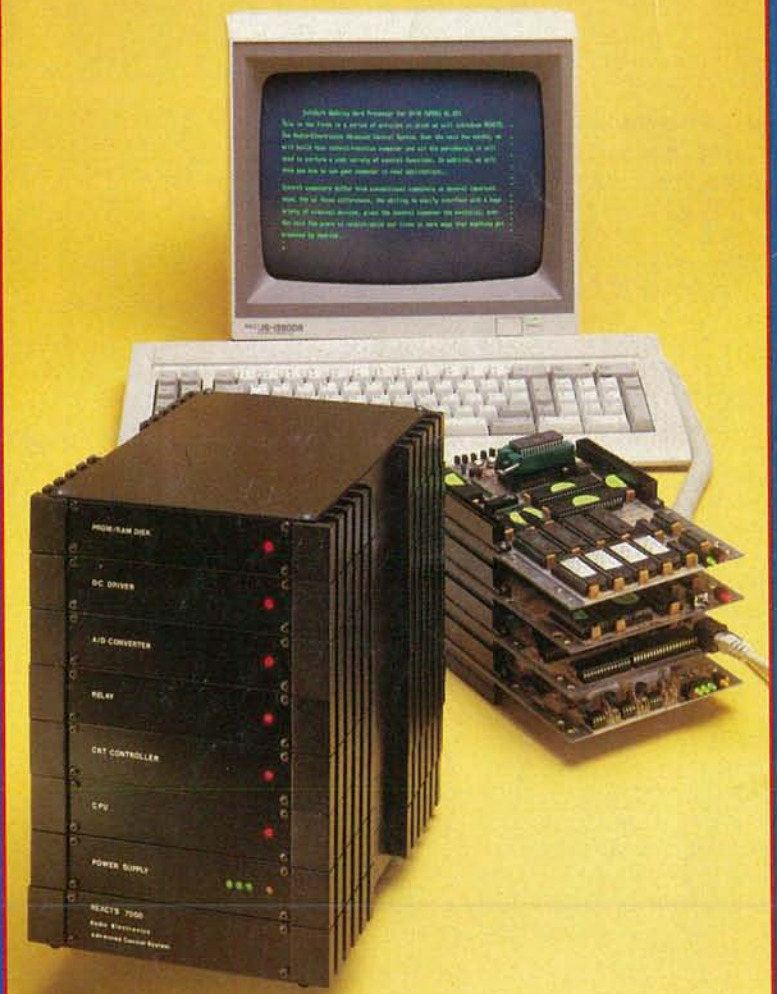


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# THE ANSWER IS IN TEK DIGITAL STORAGE:

**Now! The new 60 MHz Tek 2221 joins the world's best-selling family of digital storage oscilloscopes.** All featuring 20 MS/s *digitizing* along with familiar, full-bandwidth analog operation. It's the best of both worlds in an easy-to-use portable.

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With each scope you can capture events as narrow as 100 ns at any sweep speed thanks to Tek's proprietary peak detect mode. View events prior to or following a trigger event with pre/post trigger. Store waveforms into 4K records. Automate measurements with optional GPIB and RS-232-C interfaces. And output direct to a printer or plotter.

Tek software is available to help you make the most of the 2230, 2221 and 2220 in system configurations.

| Features | 2230 | NEW! 2221 | 2220 |
|---|---|---|---|
| Analog/Digital Storage BW | 100 MHz | 60 MHz | 60 MHz |
| Maximum Sampling Speed | 20 MS/s | 20 MS/s | 20 MS/s |
| Record Length | 4K/1K (selectable) | 4K | 4K |
| Peak Detect | 100 ns | 100 ns | 100 ns |
| Save Reference Memory | One, 4K<br>Three, 1K | One, 4K | One, 4K |
| Vertical Resolution | 8 bits<br>10 bits (AVG mode)<br>12 bits (AVG mode over the bus) | 8 bits<br>10 bits (AVG mode) | 8 bits |
| CRT Readout/Cursors | Yes | Yes | No |
| GPIB/RS-232-C Options | Yes ($750) | Yes ($500) | Yes ($500) |
| Battery-Backed Memory (save 26 waveform sets) | Yes (inc with GPIB/ RS-232-C) | No | No |
| Price | $4995 | $3995 | $2995 |

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# ON THE COVER

In a typical home or office, there are literally dozens of instances where efficiency, convenience, or comfort would be greatly increased with the addition of computer control. However, although we live in an age of computational plenty, with computers literally all around us, the problem of getting computers to effectively and efficiently communicate with and control other devices for the most part remains. This month, we introduce a project that goes a long way toward solving that problem. Called the REACTS 7000, it is a sophisticated, modular computer designed specifically for control applications. For more information on the system, turn to page 47.

# COMING NEXT MONTH

## THE MARCH ISSUE IS ON SALE FEBRUARY 4

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**Advertising Sales Offices listed on page 120.**

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# WHAT'S NEWS

## High-technology display doubles image resolution

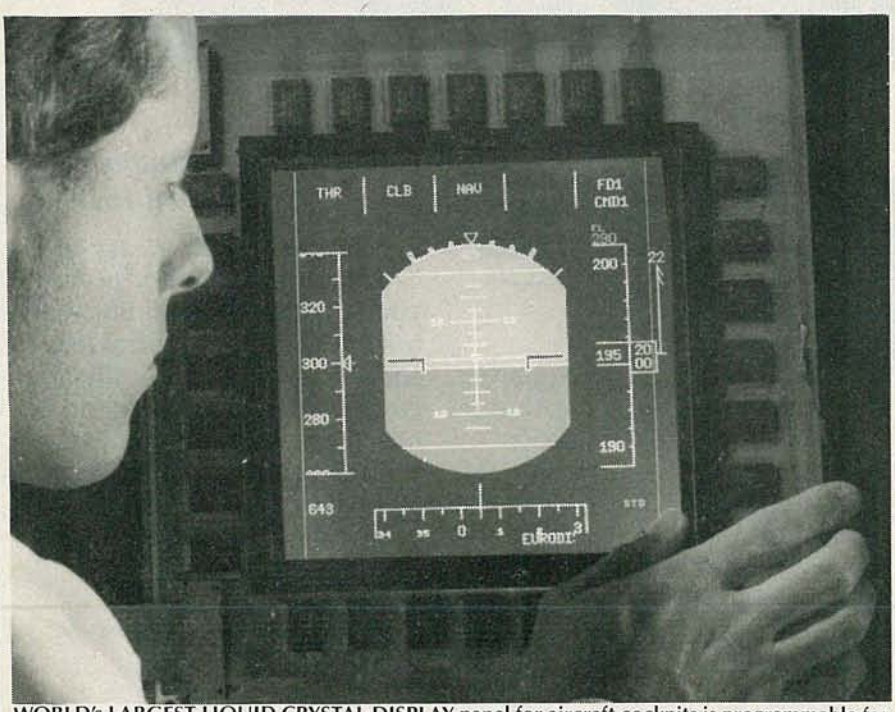
The world's largest high-resolution liquid crystal display for aircraft cockpits has been designed and fabricated by scientists of the General Electric Research Center, in a joint effort with the company's Aircraft Instruments Department.

The new panel, measuring 6.25 × 6.25 inches, is a high-resolution, full-color liquid-crystal display designed to meet military specs. It can be programmed to display engine performance, logistic and ballistic data, and attitude references, as well as radar images and video.

The new displays produce a much higher resolution image not only because of the high number of pixels on the screen (more than 28,000 pixels-per-square-inch, or more than a million in total), but because of GE's ability to position thin-film transistors at the corner of each pixel. That provides a switch that turns the liquid crystal material on or off at the point, enhancing contrast and improving the viewing angle. Sharpness is twice that of a home-TV screen.

The liquid crystals are sandwiched between two plates of glass. The inner sides of the plates are patterned with silicon structures that control the electrical charges that "paint" the images or alphanumeric characters on the LCD's screen. The unit includes a dimmable fluorescent backlight, which provides a high-contrast image over an ambient brightness range from full sunlight to complete darkness.

GE displayed a prototype panel at the Paris Air Show last year.




**WORLD's LARGEST LIQUID CRYSTAL DISPLAY panel for aircraft cockpits is programmable for display of engine performance, logistic and ballistic data, and attitude references, as well as radar images and video. The display's high resolution of 28,000 dots-per-square-inch give it twice the sharpness of a home-TV screen.**

## Expert systems used in semiconductor fabrication

In semiconductor manufacture, a typical diagnosis includes testing of "test structures" with probes smaller than the diameter of a human hair. Those test structures are fabricated on the wafer and form test chips that replace the regular ones that would be in those spots. Test results from those structures are recorded in computer memory for evaluation.

The difficulty is that the numerical diagnostic data has to be analyzed by specialists with expert knowledge. But such experts often aren't available to translate pages and pages of numbers into usable solutions to problems.

The use of a computer *expert system* being developed jointly by the National Bureau of Standards and the Westinghouse Research and Development Center may greatly simplify the testing procedure. An expert system is a software program built up from the knowledge and experience on not one, but a number, of experts in a given field.

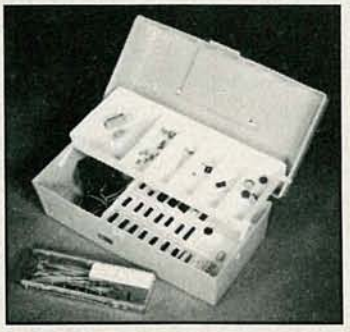
Using an expert system, data obtained from diagnostic test structures can be interpreted much easier than by older approaches. Process personnel armed with test data on a computer disk will be able to diagnose fabrication problems in a readily understood, English-language format on a computer screen.

Development of the expert system is still in the formative stage, and the National Bureau of Standards welcomes companies interested in working collaboratively with the Bureau to research expert systems further. For information, contact Loren W. Linholm, 8360 Technology Bldg., National Bureau of Standards, Gaithersburg, MD 20899 or Dr. Michael Cresswell, Westinghouse R & D Center, Pittsburgh, PA 15235. **R-E**

# EIA/CEG AUGMENTS DIGITAL AND MICROPROCESSOR COURSE HIGH TECH PARTS KITS NOW AVAILABLE

The members of the Electronic Industries Association Consumer Electronics Group (EIA/CEG) through the Product Services Committee, has marketed the illustrated parts kit for vocational schools, educators and technicians. This is the same material used in the Digital and Microprocessor Course during EIA's summer workshop programs. These workshops are organized by the Consumer Electronics Group and co-sponsored by national service organizations and state departments of vocational education.

Parts and components are contained in a lightweight tool box with individual compartments. It includes a breadboard, power supply, pre-dressed jumpers, resistors, capacitors, and integrated circuits to perform all digital exercises 1 through 25 of the Digital/Microprocessor course book listed in the table of contents. Some parts have been included for the microprocessor section but other components will have to be acquired (as listed in the Introduction to Exercises 26–31).



Individual and classroom size quantities are available at the following cost: quantities 1–9, $69.95 each, quantities 10–19, $67.95 each, and for quantities 20 or more, $64.95 each (cost includes shipping and handling). The kits will also include the Digital and Microprocessor Course book. Additional books are available at the cost of $2.00 per copy.

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# VIDEO NEWS

**DAVID LACHENBRUCH,**
CONTRIBUTING EDITOR

• **Supercable.** The influence of Super-VHS continues to spread in ever-widening circles, vastly increasing the efforts devoted to developing *H*igh-*D*efinition *T*ele*V*ision (HDTV) and various improved TV systems. The mere idea that a home device can be capable of reproducing pictures superior to those coming in over the air (or by cable) has spurred the TV establishment to act immediately.

Now, there is a proposal to use the specs of Super-VHS (more than 400 lines of horizontal resolution, separate chrominance and luminance signals) as a form of deluxe cable.

The National Cable TV Association has named a subcommittee to look into the idea of "supercable." Since an increasing number of color-TV sets are capable of showing high-resolution pictures, and more and more will have Y/C connectors (for direct input of chrominance and luminance signals), why shouldn't cable feed its subscribers a picture of the same quality, either for viewing directly or taping on Super-VHS recorders? Under one scenario, a cable subscriber would pay extra for a super channel providing him or her with a Super-VHS picture. There is some question whether supercable would require more than the standard 6-MHz bandwidth. Some cable engineers suggest that the same channel could be used to provide a standard NTSC and a super picture. Subscribers with one type of set-top converter would receive a regular 330-line NTSC signal, while those with another type would receive the 400-plus line super channel—at extra charge, of course.

• **ACTV.** That acronym stands for *A*dvanced *C*ompatible *T*ele*V*ision, and it's probably the last major project carried out by the old RCA using its in-house TV network (NBC) and research facilities (David Sarnoff Research Center). The results of six years' work, ACTV is a widescreen, 1,050-line TV system that can be transmitted within the same 6-MHz bandwidth as standard NTSC and is totally compatible with existing NTSC TV sets.

The ingenious system uses a series of subcarriers to multiplex the various elements of the picture. The "ears" (the additional width at each side of the screen) are compressed for transmission, and expanded in ACTV receivers. In standard NTSC receivers, which will continue to provide a traditional 4-×-3 picture, they are in the overscanned portion of the picture hidden by the frame of the picture tube. The 1,050 scanning lines are double the number provided by a standard NTSC transmission, but an NTSC set would only "see" 525 of them.

ACTV was announced jointly by NBC, the David Sarnoff Research Center (now part of Stanford Research Institute), and GE/RCA Consumer Electronics, whose sale to Thomson of France was pending at the time of the announcement. A computer simulation of ACTV has been presented on tape, but no equipment has yet been built. Its developers hope to build and field test the equipment this year.

ACTV is not true high-definition TV, but its sponsors believe it is at least an interim step, ideally suited for standard terrestrial broadcasting because of its compatibility with the existing system and its use of a standard 6-MHz channel. All other systems demonstrated to date either require a wider bandwidth or are not compatible with NTSC. For example, two NTSC-compatible HDTV systems (by Philips and Charles Glenn) use one standard channel and a part of another. The Japanese 1,125-line system is incompatible with NTSC and is designed for direct satellite transmission. A system sponsored by Del Rey Group is aimed at a compatible 6-MHz picture but isn't yet HDTV and is still in an early development stage.

• **Sony joins the giants.** Sony celebrated the 20th anniversary of the *Trinitron* color-TV tube by introducing two giant sizes—34 and 45 inches in overall diagonal measurement—joining other manufacturers that are fielding giant versions of conventional color tubes. The 34-inch tube is built into a "Family Stereo TV" that will retail in Japan at about $2,345. The 45-inch tube will be in a set selling for just under $14,000, and that's designed for TV viewing in public places. **R-E**

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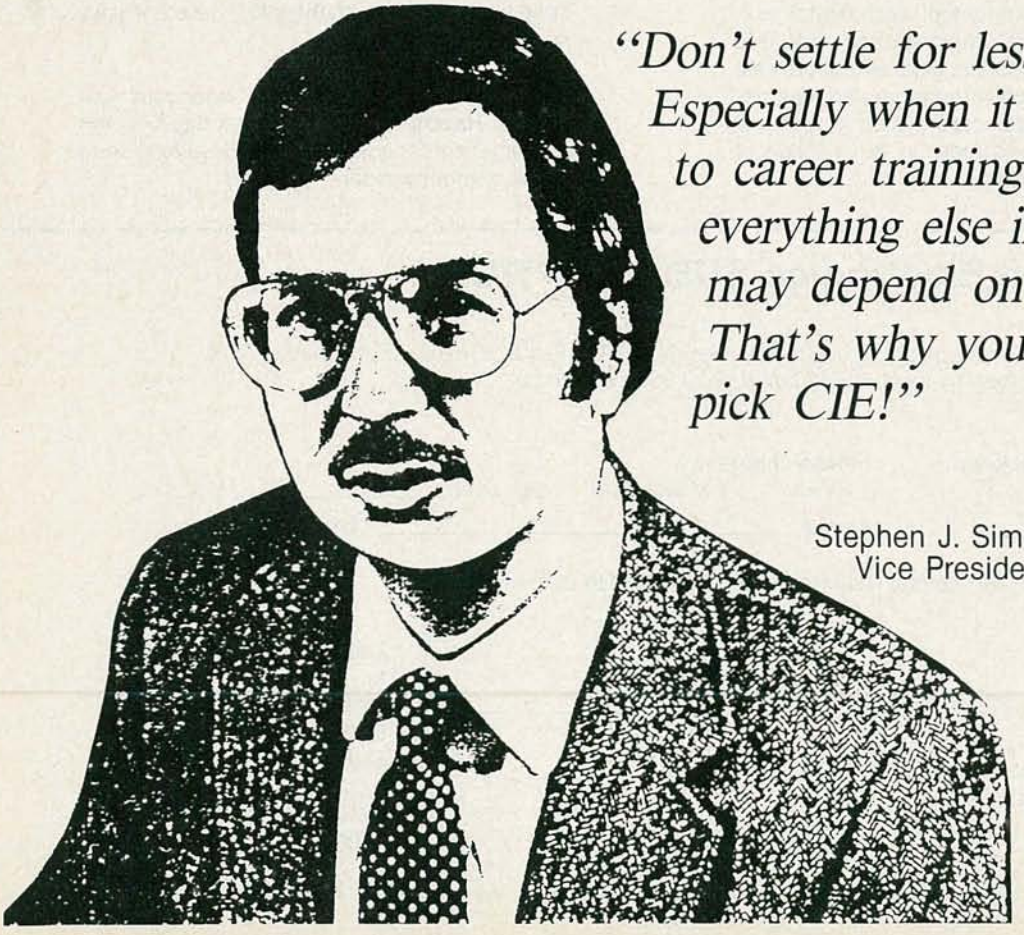

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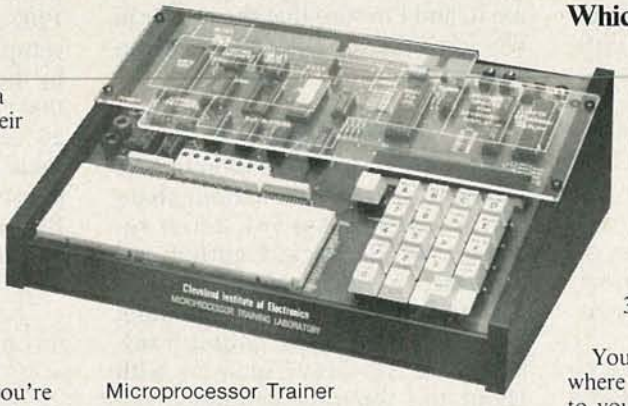


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## SYNCHRONOUS INVERTER

My thanks to Mr. J. Dale E. Holt of Manchester, TN for pointing out that my reply to D.B. (December 1986) was inadequate. He points out that all-electronic synchronous inverters have been available for many years. He owns a 2-kW unit by Acheval Wind Electronics that he purchased for approximately $1,000.00. He sent a diagram (Fig. 1) that the maker of the Gimini synchronous inverters uses to explain the theory of operation.

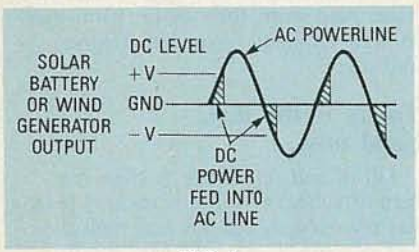


FIG. 1

The synchronous inverter takes the DC power from a bank of solar cells or a wind- or water-driven generator and switches it—through SCR's—at the zero-crossing point of the AC powerline voltage. Current flows into the power lines until the instantaneous AC voltage exceeds the DC voltage; at which time the SCR's turn off.

## MORE ON THE FISHER *400*

**I too, need a schematic for a Fisher model *400* FM stereo receiver. Since seeing your reply to J.T., of Thonotossa, FL (February 1987), here's what I've found out: 1) The model *400-C* is a preamplifier, not a receiver. 2) The *400* is listed as a new item in the 1964 Allied Radio catalog. 3) The *400-T* is a later transistorized version. 4) Sams photofacts does not have any information on the model *400*.**

**Is there a reader who can supply a photocopy of the service manual or the schematic? I will greatly appreciate it, and I'm sure that the reader in Florida will too.—G.H.M., Kingsport, TN.**

## AND STILL MORE

**Here is a possible solution to J.T.'s problem with an intermittent channel in a Fisher AM-FM stereo receiver. Awhile back, I gutted and discarded a Fisher *400* because it had an intermittent right channel caused by a defective output transformer. It is a heavy monster with about ten separate windings. Rewinding the transformer wasn't practical. I kept the good left-channel output transformer along with all of the information on how it was hooked up.**

**I don't recall whether or not the set had a printed-circuit board, but I've seen many sets of that vintage that had dual-heater circuits where the center was grounded by soldering a certain point on the circuit board to the metal chassis. Intermittent heating and flexing of the circuit board over the years can crack the soldered connection. The soldered joint makes intermittent contact, effectively turning a tube's heater off and on, or simply not passing enough current to keep the tube hot. As the tube heats and cools, its output voltage or power varies.**

**If J.T. is interested in the transformer I'll sell it for $5.00 and postage or will swap it for a standard center-tapped output transformer of the same or an earlier vintage. He can contact me through "Ask RE"—D.A.Y., Key West, FL.**

## SPEAKER LEADS TOO SMALL?

**I recently purchased a 100-watt-per-channel power booster intended for use in an automobile. I built a 12-volt, 6-amp power supply, following the diagram on page 44 of the May 1987 issue of *Radio-Electronics*. The setup works nicely, but I'm bothered by the small size of the hookup wire that came with the speakers. It's only 26 or 24 gauge. Isn't that wire too small to carry the 100 watts that the booster can deliver? For example a 100-watt floodlamp usually requires No. 18 or larger wire.—J.M.B., Ballston Lake, NY**

There is a considerable difference between delivering 100 watts of power to a floodlamp and the audio power that is fed to the speakers. Ordinary audio program material is very random in nature and a power amplifier operating at or near the 100-watt level will actually reach that level only on the random peaks of the program material. On the other hand, the sine-wave power fed to a lamp is constant, as are the losses in the power cord or transmission line.

One consideration in selecting speaker wires is their resistance. In general, the smaller the diameter (or the higher the gauge), the higher the resistance. Speakers are relatively inefficient devices, so you don't want to waste power in the connecting wires. In order to minimize power losses, be sure that the DC resistance of the speaker leads is much lower than the impedance of the speaker's voice coil.

No.-26 wire has a resistance of 4 ohms per 100 feet. If you have a 4-ohm speaker fed through 50-feet of two-conductor speaker wire, about half of the power will be dissipated in the leads.

The booster manufacturer probably used No.-24 or No.-26 wire because it is less expensive than

FIG. 2

larger sizes. And, since power boosters for car stereos are usually installed within a few feet from the speakers, the power loss in the small-gauge wire is negligible.

You purchased a 100-watt booster amp and 120-watt speakers so you must want a high volume level. For the maximum available audio power while putting your mind at ease, use 18-gauge speaker wire. Its resistance is only 0.64 ohm per 100 feet. You can also use zip-type lamp cord, which uses 18-gauge wire.

## OLD CAPACITORS AND PCB's

**I collect and restore old TV sets and very often I have to replace the capacitors in the sweep circuits. I've heard that some old capacitors like the ones in Fig. 2 contain PCB's (*P*oly *C*hlorinated *B*iphenyl). What is the best method of disposing of them?—B.T., Atlanta, GA**

I can't confirm nor deny that the oil is a PCB material. My local environmental agency office seems to only think in terms of tens of gallons of PCB material in transformers and capacitors used in power transmission. They can't understand that such material might be used in anything smaller and cannot offer any suggestions.

If the problem were mine, to avoid contaminating the environment I'd pack the leaky capacitors in a coffee can and, when I had a half can or so, would fill the can with cement or mortar mix, bury it, and forget it. **R-E**


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# LETTERS

## VIDEO PALETTE

In building the Video Palette video-effects generator (September–October 1987), I noticed several errors and discrepancies: No PC-board mounting locations are given for C11 or C14. In Fig. 12, the centers of J1, J2, and J3 are shown all tied together. You don't show where on the main board to connect the +5- and −5-volt leads from the effects board. The A lead from the effects board does not appear to connect to anything on the main board. Finally, the orientation of IC7 appears to be incorrect on the PC board.

*RICHARD E. RICE*
*Pickerington, OH*

*The gremlins seemed to have done a thorough job this time: Jacks J1–J3 are incorrectly wired in Fig. 12; they should be wired as shown in Fig. 10, and only J3 should connect to S2-b. The +5-volt connection on the main board should be made at the junction of R14/R18; the −5-volt connection should be made at the junction of R19/C13. On the main board, install R33, a 10K unit, between the pad next to the A-lead pad and the hole adjacent to R34; that will tie the A lead to the rest of the circuit. And IC7 is indeed installed backwards. As to the missing capacitors, although they are shown in the schematic, C11 and C14 are not needed for proper operation and have been eliminated from the design.—Editor*

## CORRECTIONS

In the article "SMT Project: A Business-Card Tone Generator" (**Radio-Electronics**, November 1987) Forrest M. Mims III incorrectly states that sheet resistivity is specified in units of ohms per square centimeter. The unit of sheet resistivity is ohms per *square*; all squares of the same material and thickness will have the same resistance. For example, if a material has a resistance for a given thickness of one ohm per square, a ¼-inch square will measure one ohm and a ½-inch will also measure one ohm.

Looking at Fig. 1 in the article, the ½-inch square can be seen to be equivalent to four ¼-inch squares. Looking at only the top two, you have one ohm in series with one ohm, equalling two ohms. That is paralleled by the identical bottom two. Two ohms in parallel with two ohms is one ohm. Following that line of reasoning, a square measuring one centimeter on a side will measure one ohm. However, a rectangle with the dimensions ¼-centimeter by four centimeters, which is equivalent to 16 quarter centimeter squares in series, will measure 16 ohms. Both cover an area of one square centimeter, but they have widely differing resistances.

Thus, it is obvious that sheet resistivity must be indicated in ohms per square, not ohms per area. Table 1 in the article also proves that, since the resistances of the 1" × 0.02" lines (equal to fifty squares of .02" on a side) is exactly fifty times the resistivities.

Mr. Mims also states that silver has several times the resistance of gold. That may or may not be true of gold and silver conductive paints, but it is definitely not true of the elements—short of superconductors, silver is the most conductive metal.

ALAN RAUCHWERGER
*Rochelle Park, NJ*

*You're absolutely correct, and we apologize for some over-zealous editing regarding resistivity specifications.—Editor*

## ELECTRONIC COMBINATION LOCK

*It has come to our attention that the two IC's used in the "Electronic Combination Lock," which appeared in the November 1987 issue of* ***Radio-Electronics****, are difficult to obtain in single-unit quantities. However, they are available from Circuit Specialists, P.O. Box 3047, Scottsdale, AZ 85257. The MC145026 sells for $3.60; the MC145028 sells for $4.80. Add $2.00 shipping and handling, and AZ residents must add appropriate sales tax.—Editor*

## COMPUTER GRAPHICS ON VCR

The latest copy of **Radio-Electronics** arrived today and I've been enjoying it. I've been reading the Gernsback "Radio-" publications all my life—I'm 82 now.

I have a simple project that other readers might enjoy. If you use a television set as a monitor, you can save the pictures on your color computer on a VCR. Connect the output of the computer to the input (antenna) connection of the VCR. Connect the output of the VCR to the TV monitor. Now you're ready to record.

I use channel 3, as it is not used here for TV, and a Tandy *Color Computer* to do that. An old Timex/Sinclair computer will do, but it won't give you color. I write notes about the program I record—the date, time, etc. The system also comes in handy for business presentations. Instead of drawing graphs on paper, photographing them, and having

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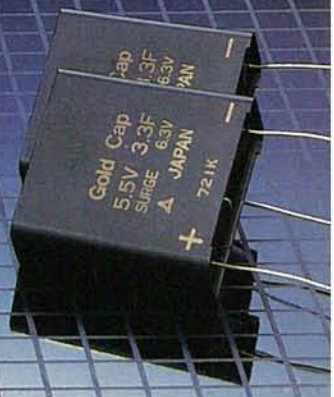


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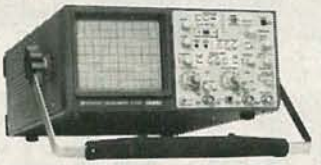
100MHZ 

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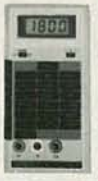

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Forrest Mims (Letters, January 1988) would have **Radio-Electronics** play the wise old grandfather who, in his infinite wisdom, withholds information that he deems unfit for the irresponsible youngsters' consumption.

WILLIAM RITZ
*Cleveland, OH*

### ACCURACY IN TEST EQUIPMENT

Gregory D. Carey, in his article entitled "How to Analyze Waveforms" (**Radio-Electronics**, December 1987), did a disservice to all technicians by not stating that the accuracy of a digital scope is 2% only if it is calibrated at regular intervals. Being digital does not necessarily make it more accurate—especially if it isn't properly calibrated.

His coverage of the benefits of using newer, digital equipment when more precise measurements are required was very good. However, the technician must be aware that calibration is essential to ensure the continued accuracy of digital equipment.

RAYMOND E. TOWNSEND
*U.S. Army Calibration Technician*
*Fort Carson, CO*

### ELECTRON FLOW

I was interested and pleased to see the two early examples of the use of positive current convention ("conventional current") reproduced in Figures 3 and 6 of Martin Clifford's "The Early Days of Radio" (**Radio-Electronics**, December 1987). However, I was more than a little disappointed in his misinformed comments about that current reference in his section entitled Electron Flow.

I realize that his comments rep-

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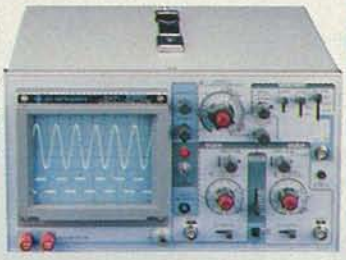

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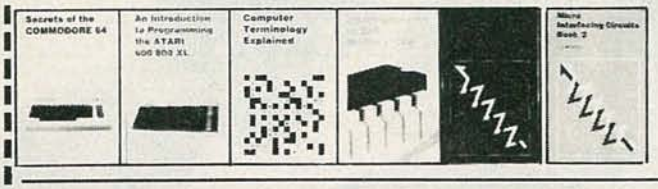

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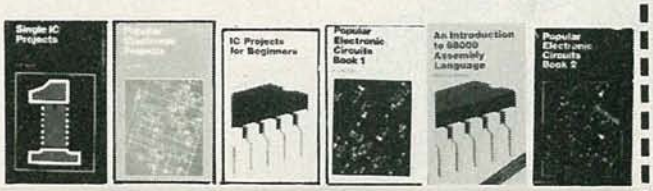


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resent a point of view that is widely held among technicians, but his summary dismissal of conventional current as an archaic and mistaken notion "that never really existed" is hardly consistent with the following facts of which he should have been aware, and could have very quickly verified.

The positive current convention is an implicit and integral part of the definition of electric current accepted by those international organizations responsible for determining scientific and engineering standards.

What Mr. Clifford calls "electron flow" and suggests is the only valid way to express current flow is utilized only in parts of the technician community. It is taught only in military schools, vocational technology curricula, and at some community colleges.

I realize that "electron flow" has a simplistic appeal and that the positive current convention may seem perverse and obscure at first glance. However, we need a common and universal definition of electric current and current direction—used by *all* writers, students, teachers, and practitioners—to ensure precise and unambiguous communication of ideas and information. That definition must be consistent with, and at the same time embrace all that is known about, the physics and chemistry of materials.

The most widely accepted definition for electric current is that it is the movement of electric *charge*. There are two kinds of charge: positive and negative. Thus it is not reasonable to limit the definition of current to the movement of electrons alone.

From what I can determine, the real source of confusion was a small number of writers and teachers who, in the mid-1930's, wanted to simplify electron-tube actions and their associated circuitry to the barest, zero-order, non-mathematical essentials. They wanted a simple conceptual model in which the electron stream inside the tube and the current outside the tube went the same way, and they didn't want any messy algebraic signs hanging around. In so doing, they discarded the algebraic sign properly associated with current in the negative direction, and dismissed positive ion motion as being unimportant.

That sort of teaching and writing became the backbone of the technical training given to thousands of military technicians during World War II. When their use of "electron flow" was criticized, it was easier to rationalize by attacking "conventional current" with myth, misinformation, and innuendo than it was to deal with the facts of the situation.

I am extremely angry with the teachers and authors (and, yes, even editors) who continue to confuse good technical dialogue by using the "electron flow" atrocity. I am angry with those who endeavor to discredit the positive current convention by suggesting it is defective and that those who use it are less competent than those who use "electron flow." I'm also angry with those who say it really doesn't matter which convention you use.

I think it is time to identify "electron flow" as a simplistic, archaic,


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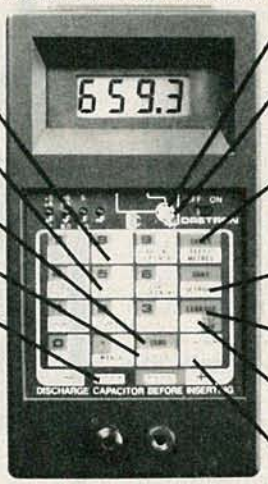


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and obsolescent idea whose time and usefulness has passed. It's time to identify those writers and teachers who cling to and defend "electron flow" as less than up-to-date and not well-informed. It is also time to stop teaching newcomers to the electronics community a lame-duck model for electricity that they must unlearn when and if they get serious about it. If you're going to learn electronics, why not just get it right the first time?

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### INVENTION PROTECTION

As program manager of the *W*isconsin *I*nnovation *S*ervice *C*enter (*WISC*), I have the opportunity to interact with a variety of people involved in new-product development. Our non-profit service, at the University of Wisconsin-Whitewater since 1980, assists individual inventors and entrepreneurs in assessing the market feasibility of their innovative ideas at early stages in the development process.

We've recently received many inquiries about certain "invention-development" firms that apparently prey on inventors' vulnerabilities. According to dissatisfied clients, extremely high fees were demanded up-front in exchange for promises of invention development. In many cases, inventors said they received only the "promise" for their investment.

As with most other endeavors, invention-development assistance is offered by both reputable and questionable sources. Before dealing with a company that promises commercial development of an idea, potential clients should consider these questions:

- Is there a substantial up-front fee involved (over $400) for just an initial evaluation? Is there a subsequent fee involved?
- What is the company's success rate for placing inventions? Do they have data/references to support this? What percentage of their clients have received more money than they paid?
- Who are their references? Once supplied, check them out.
- Do organizations such as the Better Business Bureau, the

Federal Trade Commission or Chamber of Commerce have any information on the company?

It is also recommended that an inventor consult with an attorney before a contract is signed.

We at the WISC are committed to encouraging the independent inventor. Fraudulent exploitation discourages individual creativity—a vital source of social and economic progress. Affordable invention evaluations are still available at the WISC and other non-profit organizations, but we urge inventors to proceed with caution when considering an invention-development firm.

DEBRA KNOX-MALEWICKI,
PROGRAM MANAGER
*Wisconsin Innovation Service Center*
*402 McCutchan*
*University of Wisconsin-Whitewater*
*Whitewater, WI 53190*

## CERTIFICATION

As an electronics technician with the United States Marine Corps, I appreciated Clem Small's article on certification in the August issue of **Radio-Electronics**. It helped me realize that, although I have 22 years of electronics experience in the military, I will however need certification to start my second career.

I wrote to the organizations listed in the article, and most responded promptly with the information I requested. However, one—The National Association of Business and Educational Radio—has moved and left no forwarding address with the Post Office. I would appreciate hearing from any member of that organization who can provide me with the current address.

Your magazine is read and studied by a majority of those Marines who work in our division. It keeps us up to date on what is happening and what is new in electronics. Keep up the good work.

LAWRENCE E. FLICK
*MSgt., U.S.M.C.*
*NCOIC Ground Electronics Maintenance Div., Communications-Electronics Department*
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CONSUMER BUZZER

New solid-state and digital TV sets, stereos, and videorecorders are tougher to repair than old-fashioned tube type sets and require special training for the service technician who works on them.

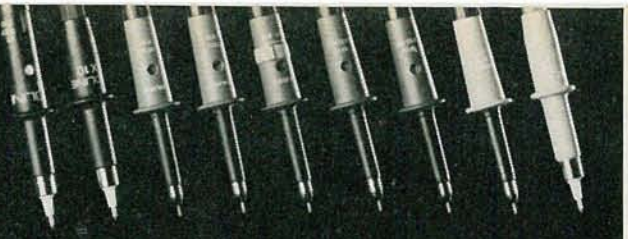
Only a few states have laws requiring competency tests for licensing technicians who repair consumer electronics, but fifteen years ago the International Society of Certified Electronic Technicians (CET) began its own certification program to qualify these technicians and those in industry. To carry the CET designation, technicians must have four years experience and pass a rigid examination on general electronics and a specific area of expertise such as audio or radio-TV.

Many consumers look for a Certified Electronic Technician in the shop when they need any electronic item repaired.

**Free Consumer Checklist**

A consumer checklist for selecting a service shop is available free by sending a stamped, self-addressed envelope to: Checklist, ISCET, 2708 West Berry, Fort Worth, TX 76109. The list reminds consumers to check such items as "Does the business have the parts for your particular brand?", "Did you get an estimated price?", and "Did you check this company with the Better Business Bureau?"

**Modern electronic equipment such as digital TVs or stereos should be repaired by specially trained people.**

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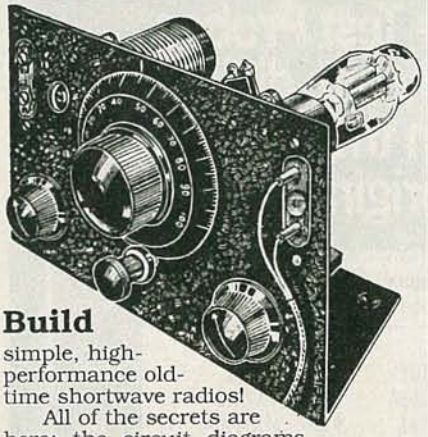

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Also included is a new chapter showing how you can use transistors to replace hard-to-find vacuum tubes. You'll even see the circuit that was lashed together on a table top one night using junk box parts, a hair curler and alligator clips. Attached to an antenna strung across the basement ceiling and a 9 volt battery, signals started popping in like crazy. In a couple of minutes an urgent message from a ship's captain off Seattle over 1500 miles away was heard asking for a navigator to help him through shallow water!

These small regenerative receivers are extremely simple, but do they ever perform! This is a must book for the experimenter, the survivalist who is concerned about basic communication, shortwave listeners, ham radio operators who collect old receivers, and just about anyone interested in old-time radio.

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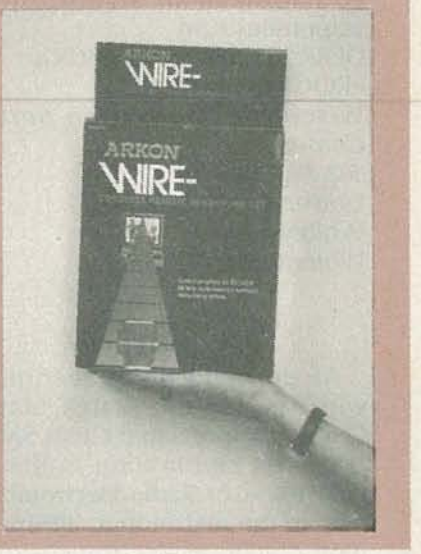


CIRCLE 20 ON FREE INFORMATION CARD

OVER THE PAST TEN YEARS, OR SO, infrared signals have became the defacto standard for remote-control applications. But, as many experimenters know, infrared can also be used for short-distance wireless communication, such as in cordless headphones for the convenience of private listening.

The first cordless infrared headphones were not successful as mass-consumer items because they were too costly for the average person, too bulky to wear comfortably, and had unsatisfactory performance. Over the past few years, however, the technology has improved to the point where low-cost, comfortable units with outstanding performance are now available. One of those is the Arkon *Wire-Free*, which sells for $69.95. At that price, it is among the least expensive units of its type. Note, however, that the *Wire-Free* is a *mono* unit, though it does have a switch-selectable *Spatial Sound Around* mode that provides an electronically enhanced, pseudo-stereo effect.

### Using *Wire-Free*

The *Wire-Free* consists of the transmitter (4½" wide, 3½" deep and ¾" high), the receiver (2½" wide, 3½" deep and ¾" high), the AC adapter, and lightweight headphones. The receiver accepts a standard miniature mono or stereo phone plug, so you can use your favorite headphones instead of the ones supplied to you by the manufacturer

The AC adapter is a wall-plug type. An on-off switch on the transmitter lets you turn the unit off without unplugging the supply. A red LED on the unit lets you know when power is on.

The transmitter has a hard-wired four-foot input cord that terminates in an RCA phono plug. That plugs into the audio-output jack of a TV, VCR, compact disk, hi-fi or

other audio source. Adapters to accommodate ¼-inch and miniature phone jacks are included with the unit. For TV sets or other devices without an audio-output jack, Arkon sells a sensitive microphone for $18.95, postpaid. That microphone is mounted in a small bracket that is held in front of a speaker grille with double-sided tape (supplied). With that microphone the speaker volume can be set at a nearly inaudible level and still supply enough signal to drive the transmitter.

A thumb-wheel volume control on the side of the transmitter lets you compensate for different audio-input source levels. To set the proper level, you adjust the volume control and watch two rectangular LED's on the front of the unit—a green one and a red one. If neither LED is lit, the volume is too low. Adjust either the source volume or the unit's volume control until the green light comes on with audio peaks. Advance the volume a bit more until the red LED goes on, and then back off until the red LED does not light. The red LED indicates overload, which could cause distortion. The adjustment technique is simple, but effective.

The receiver uses a standard 9-volt transistor-radio-type battery, (not included); an alkaline unit is recommended. A small cover is slid back and removed, the battery dropped in (oriented to the polarity shown), and the cover is then slipped back on.

The headphone jack is on one side of the receiver and an on-off/volume control is on the other side. You plug in the headphones, turn on the unit, and adjust the volume. When the unit is on, a small, red LED lights to let you know you have power. As the battery loses power, that LED gets dimmer and finally goes out.

The 900-nm infrared signal is FM. The frequency response is fairly wide; it is specified as 30 Hz to 18 kHz. That allows you to use better headphones to good advantage when listening to music or other material. For applications where wider bandwidth is not needed, such as speech, the lightweight headphones supplied with the unit work well. Distortion is specified as less than 1%. The sig-


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nal-to-noise ratio at 30 feet is specified as 40 dB.

You don't have to be particular about aiming the receiver directly at the transmitter. As a matter of fact, in most circumstances it works just as well pointed away from the transmitter since the receiver is very sensitive and the room is virtually flooded with the infrared signal from the transmitter as it bounces off the walls and ceiling. A belt clip is provided on the transmitter if you wish to use it while you walk around the room.

The receivers's high sensitivity helps eliminate noise/static problems, but it can work against the system in certain situations. More specifically, if the *Wire-Free* receiver is used in very bright light, such as near a large window with the sun shining, or under bright indoor lighting that has an unusually high infrared component, the unit may overload and shutdown. That won't harm the system, and can be compensated for by simply turning the receiver away from the light source, by moving the receiver to a darker area, or by reducing the amount of ambient light in the listening area. If you cannot avoid using the unit under unusually bright lighting conditions, you can cut back the sensitivity by covering part of the sensor (red) area on the receiver with dark tape.

Other than that problem, we found that the unit worked well. The lack of true stereo is a shortcoming, but remember that this is a low-cost, low-end unit. The manufacturer does offer a stereo version (called *SoloSound*) for $109.95; stereo units that are available from other manufacturers can run as high as $481.

But for private TV listening, or for sound reproduction for the hard-of-hearing (without blasting speakers) the unit is hard to beat. For more information on the Arkon *Wire-Free*, the *SoloSound* stereo wireless head phones, or other Arkon wireless products, contact the Art Sea Development (U.S.A.) Corporation (11627 Clark St., Suite 101, Arcadia, CA 91006). **R-E**

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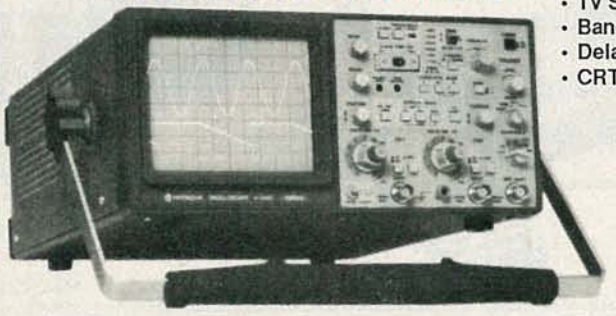

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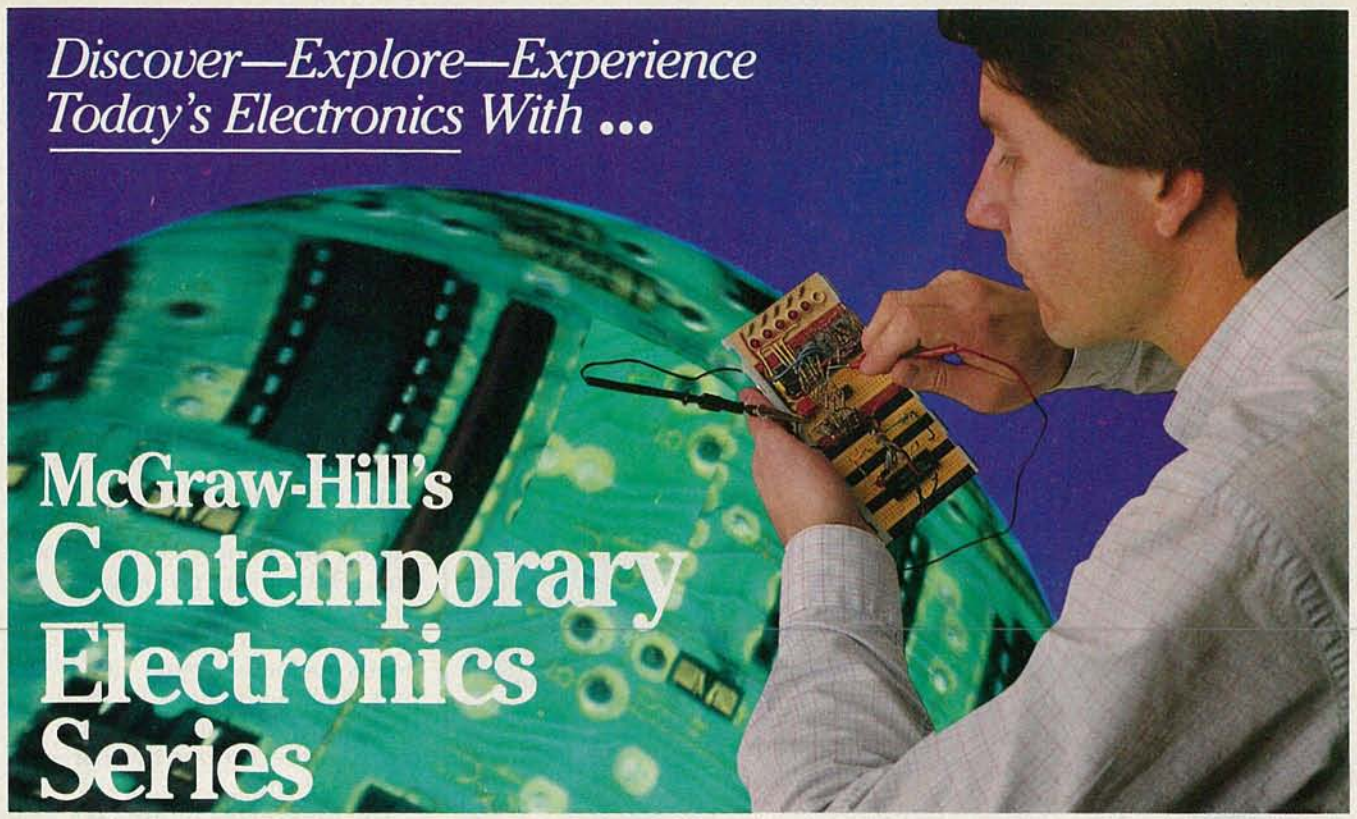
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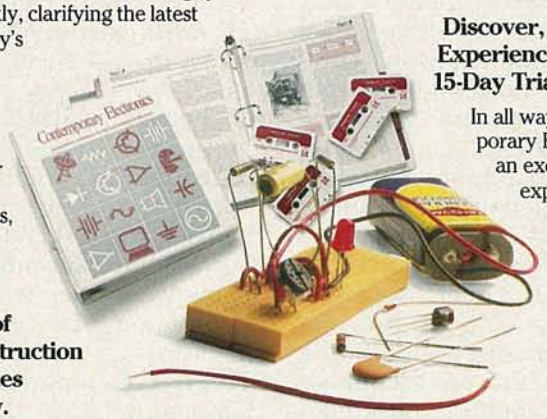


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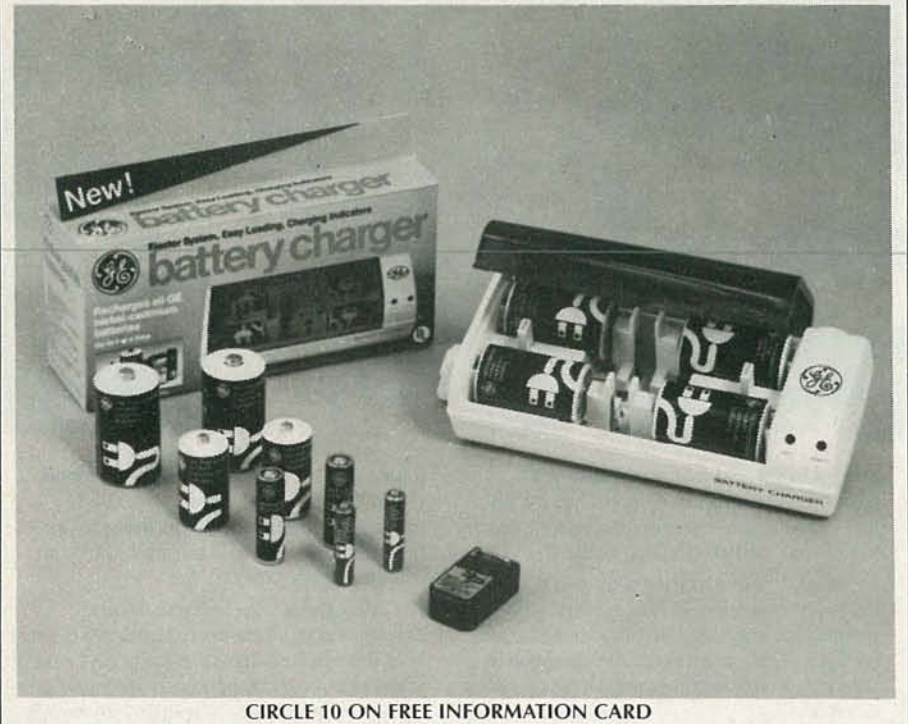


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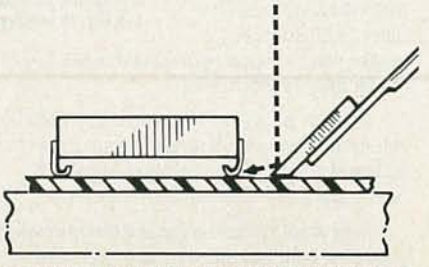
**BATTERY CHARGER.** General Electric offers a battery charger that can accommodate various combinations of household-sized rechargeable batteries—everything from AAA to 9-V.

GE nickel-cadmium batteries can be recharged up to 1000 times; the new battery charger is extremely versatile and is much easier to use than earlier models of battery chargers. A flip-up, see-through cover opens to sliding plastic fixtures that can accommodate all five common household-battery sizes. The unit can recharge up to four AAA, AA, C, or D sizes, or two 9-volt batteries at a time.

The battery charger is housed in a durable high-impact plastic case; features include a six-foot UL-listed cord, rubber feet to prevent sliding or scratching on any surface, and an indicator light to show when the charging cycle is completed. The battery charger sells for under $12.00.—**General Electric Company,** Nela Park, Cleveland, OH 44112.

**SPECIAL MIRRORS.** Metro Optics, Inc.'s 90° mirrors let the user see *under* electronics components such as surface-mount devices with "J" leads while looking down with a Metron 3-D scanner or a microscope.

Tilting a PC board to see the solder connections from an angle helps, but even tilting to 90° isn't enough because components (except for the outer row) block off the view of the solder connections in the next row. The 90° mirrors require no tilting of the PC board, and components from one row cannot block the view of the next one. The mirrors go between the rows and permit both a top-down view and a 90° view. If the user needs to focus farther under the part, that can be done by focusing down, and the line of focus will move farther *under* the part—an inch, if desired.



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The Metron 90° mirrors come in three sizes. The *Standard* 90° mirror is the largest and will fit component spacings of 0.225-inch or wider; it is priced at $50.00. The *Thin* 90° mirror will fit in spaces down to .080-inch, and is priced at $100.00. The *Extra Thin* 90° mirror can handle components spacings of as little as .035-inch, and is priced at $250.00. All the 90° mirrors are canted to permit looking at all sides of a component.—**Metron Optics, Inc.,** 809-815 Academy Dr., P.O. Box 690, Solana Beach, CA 92075-0690.

**APPLIANCE TIMERS.** Intermatic's Time-All models *SB111B* and *TB111B* single on/off timers, and models *SB711B* and *TB711B* variable on/off timers, offer homeowners important safety and security features.

Plug-in timer *SB111B*, and tabletop version *TB111B*, can ensure that appliances are not left on all day. They are ideal for coffee pots, irons, and electric curlers—those appliances that are often left on in the morning rush to leave the house. They can also convert a standard coffee maker to one that starts brewing before you're out of bed. For crime prevention, they can create a "lived-in" look by timing lamps.

The 15-amp model *SB711B* plug-in timer adds a new dimension to

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home security by switching lamps on or off at slightly different intervals each day, making the "lived-in" illusion more realistic. It can keep appliances on for as long as 23¼ hours, or as short a period as 45 minutes. A manual ON/OFF switch overrides the automatic setting so that appliances can be used whenever desired. The variable timer is also availabe in a tabletop version, model *TB711B*.

The suggested retail price for model *SB111B* is $9.95; $13.95 for model *TB111B*. Models *SB711B* and *TB711B* list for $10.95 and $14.95, respectively.—**Intermatic Inc.,** Intermatic Plaza, Spring Grove, IL 60081.

**TOOLS.** Jensen Tools' *Telvac* Basic Service Kit is designed for field service, in-house maintenance, trade schools, and personal use. It contains over 40 high-quality hand tools in a solid wood/vinyl case

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The *Telvac* basic service kit is priced at $189.00.—**Jensen Tools, Inc.,** 7815 S. 46th Street, Phoenix, AZ 85044.

**HEADPHONE STEREO SYSTEM.** The Aiwa model *HS-PX700A* incorporates Dolby B and Dolby C noise reduction and also features DSL-EX (*D*ynamic *S*uper *L*oudness) that offers a wider, flatter frequency response for naturally balanced sound at all listening levels. Separate slide controls for high and low

*continued on page 37*


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# COMMUNICATIONS CORNER

**HERB FRIEDMAN,**
COMMUNICATIONS EDITOR

## Pinning the blame

SEVERAL YEARS AGO, THE POLICE OF A major city, who were fed up to their blue hats by politicians who really didn't care two hoots about any of the civil servants, revolted in the only way they could short of striking: They simply broadcast nonsense on their radio network. It all started with a phantom voice asking, "Who dat?" Another voice asked, "Who dat who said who dat?" Then, "I know who said who dat?"; and so it went, hour after hour.

Now Hell hath no fury like a politician ridiculed, for that's what the "Who dat?" was, and the morning papers headlined the mayor's and the police commissioner's threats to hang the whole police force if necessary. The way the mayor and the commissioner told it, the time spent by the boys in blue asking "Who dat?" allowed criminals to run wild in the streets. In fact, however, the hundreds of man-hours the mayor ordered to be wasted trying to identify voices from air-check tape recordings probably resulted in more street crime and arson than a century of "Who dats?"

Today, the problem of identification would most likely not exist. Not because the politicians are any smarter—they most certainly are not—but because transmission identification has become so important a part of both cost accounting and legal defense that most communications systems are upgrading to automatic transmission identification. Where does "legal defense" come in? Simply because virtually any time a person dies before an ambulance or the EMS team arrives, some hot-shot *street lawyer* will claim the response was excessively late and agitate the bereaved family to institute a lawsuit.

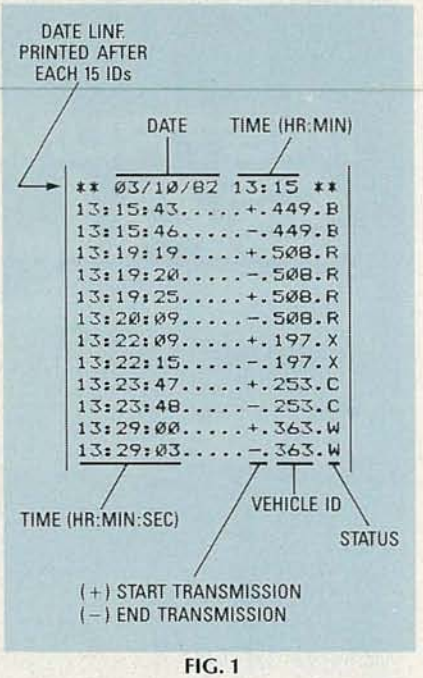


FIG. 1

### Accountability

In fact, our society has become so complex that it is essential that we have the capability to provide almost a second-by-second accounting of our communications. How else do we get accountability—which in plain English means "Who can we stick with the blame?"

Until recent times, the best system for communications accountability was the logging recorder, a special ultra-slow-speed tape recorder (so it could run unattended for up to a day) that recorded all communications traffic, as well the date and time on a special time track. If you wanted to find out what was said or who was called at a specific time, you simply ran the logging recorder at a fast speed until a digital readout indicated the desired time (and date), and then listened to the channel traffic. It's the same kind of system the police use to record emergency calls.

But while the logging tape can tell you what was said and when it was said, it can't tell you who said it; particularly so since the modulation characteristics of modern transmitters are only a shade better than that of two paper cups connected by a string; so it's often difficult, if not impossible, to distinguish the difference between male and female, child and adult.

What was needed for true accountability was automatic transmitter identification, so that when the transmit switch was pressed the first thing that goes out is the mobile's or hand-held's ID number, which is indicated both on the dispatcher's console display and on a printout. The console display shows the time and the ID number; the printout can show the vehicle's ID number, the date, and time the transmission started, the time the transmission ended, and even the status of the vehicle. For example, if a taxi has its flag up or down, if the vehicle is moving or stopped, or if the vehicle is in trouble (keyed by a switch under the driver's seat). A sample printout from an ANI (*A*utomatic *N*umber *I*dentification) system of the Control Signal Corp. (1985 S. Depew St., Denver, CO 80227) is shown in Fig. 1.

A really big feature with some units, such as the ANI, is an automatic time-out for stuck mobile-unit PTT (*P*ush-*T*o-*T*alk) switches, which would result in the channel being continuously jammed. If the mike's PTT switch jams closed, the dispatcher's console sounds an alarm and identifies the offending unit. After a preset time, the ANI encoder in the mobile automatically shuts off the transmitter. While that might take the transmitter out of service until the vehicle returns to the shop, at least it unjams the channel for other users.

More often than not, however, the primary purpose of automatic identification is to stop horseplay and eliminate mischief, such as "dead carriers," microphone clicks, belching, foul language, and "Who dats."

### How it's done

Depending on the particular communications system, the identification data can be sent via subaudible or audible tones. The disadvantages of subaudible tones are that they can't be used if the system already uses subaudible tones for CTCSS (tone squelch) or if the signal must be sent over conventional telephone lines, and every unit in the system must be able to handle subaudible tone.

Audible tones, on the other hand, will pass through any kind of communications equipment. In Control Signal's ANI system, a 3-digit ID code is a 100 millisecond (1/10 second) two-frequency FSK burst after the transmitter is keyed. (The delay between keying the PTT switch and the tone burst is adjustable to accommodate the particular communications system.) Six half-cycles of the base (audio) frequency is a mark, and three half-cycles of one-half the base frequency is a space.

As you can see, since the ANI system uses conventional audio tones that fall within the passband of conventional communications gear, including telephone circuits, it can easily be added to just about any mobile-base system, providing 100% accountability. Ah, yes! Just when you think Big Brother has exhausted all his wiles and guiles, he can come up with yet another. **R-E**


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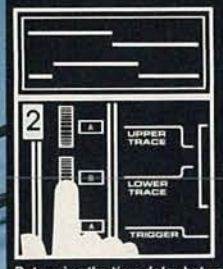
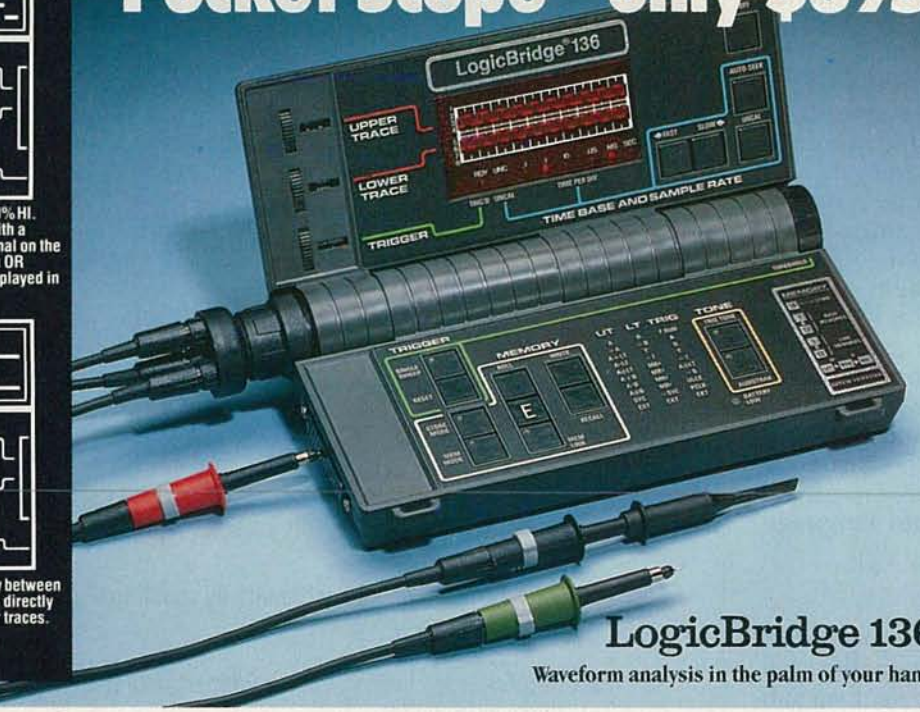
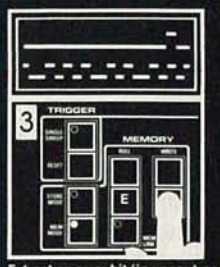
Compare a gate pulse (50% HI. 50% LO) on the A input with a microprocessor clock signal on the B input using the Boolean OR operator. The result is displayed in the upper trace.

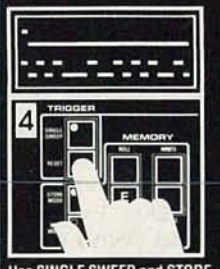



Determine the time delay between two input signals A and B directly from the upper and lower traces.




Extract an error bit (in upper trace) by an EXCLUSIVE OR comparison to a known good bit pattern (in lower trace). Results are stored in MEMORY MODE and recalled to the display.




Use SINGLE SWEEP and STORE MODE to display serial data input B (lower trace) after the occurrence of the single shot event A that is being displayed in the upper trace.

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*continued from page 33*

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*continued on page 42*


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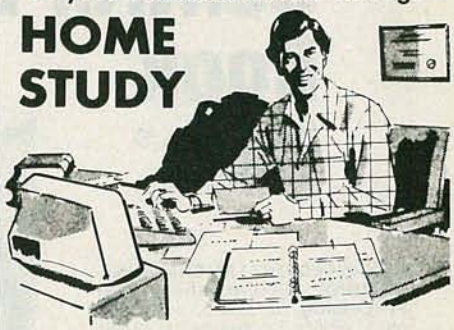

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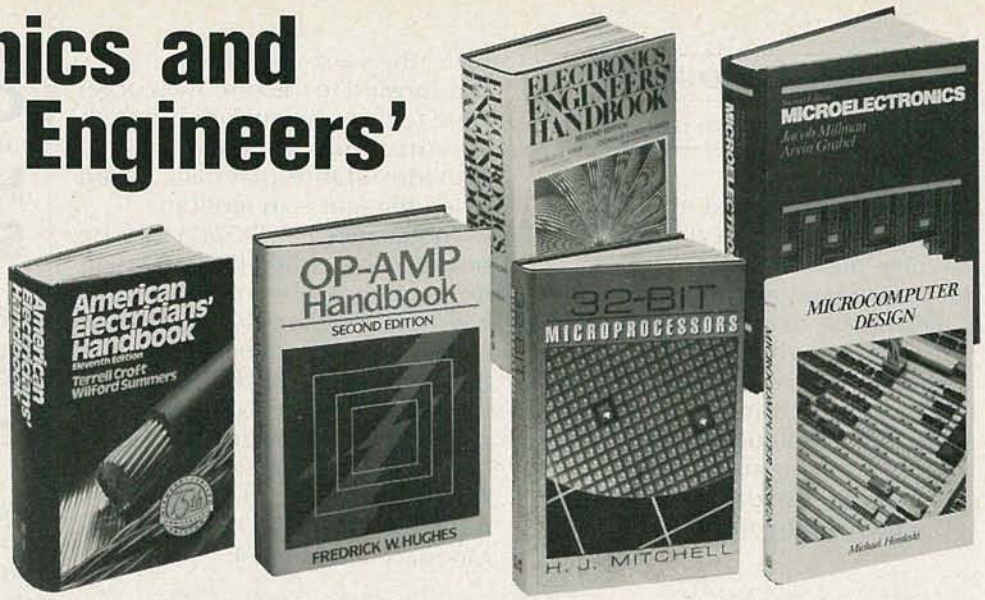


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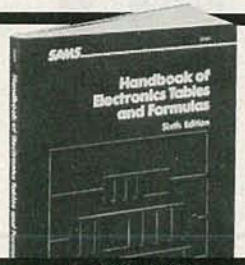


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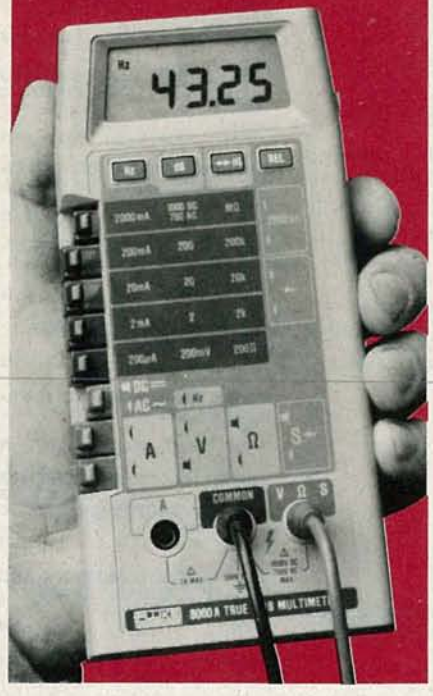

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## NEW PRODUCTS

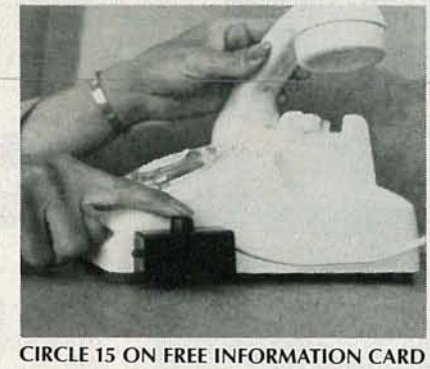
*continued from page 37*

whether the phone is in use without lifting the receiver. It also functions as a simple-phone circuit tester. You can trace problems, such as no dial tone or a dead line, to their source—modular jack, phone line, or the telephone unit.

Installation is simple. Using the 2-way T-adapter and Velcro pads supplied with the *TELE-MATE*, it can be connected to either the wall jack or to the phone itself.

The device itself is also simple—a small box with a push-button and red indicator light. Each of its functions is achieved by various combinations of pushing the button and observing the light, with the phone either on or off the hook.

*TELE-MATE* has a suggested price of $14.95.—**B&M Engineering**, P. O. Box 823, 2551 Galena St., Simi Valley, CA 93062.



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The watch can be entirely washed with a detergent to remove any traces of grease or other contaminants that could interfere with contact. The coiled cord is connected to the wriststrap by a detachable snap contact with a 1-megohm resistor incorporated within the mold.

The *3S-Watch* is available as a gent's and a lady's model; the price, which includes the coiled cord, is $59.50.—**Solder Absorbing**

*continued on page 96*


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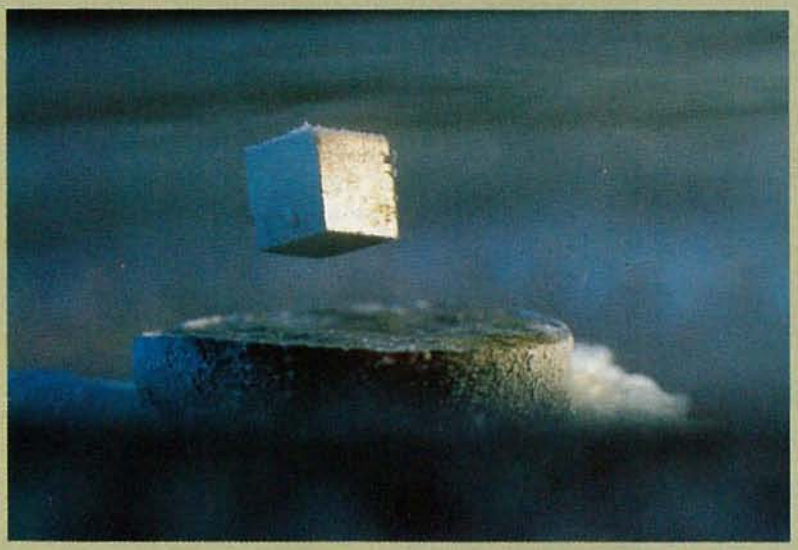
# SUPERCONDUCTIVITY



# BREAKTHROUGHS

*A true revolution in physics has only just begun.*

**BRIAN C. FENTON,** MANAGING EDITOR*

IMAGINE TRAVELING FASTER THAN 300 miles per hour in a train levitating above its tracks on a magnetic field. Imagine transistors operating more than 20 times faster than those of today, yet consuming only one twentieth the power. Imagine an energy-storage device so efficient that you could travel from coast to coast in an electric car—on a single charge.

All those dreams won't be fulfilled this year, but thanks to the breakthroughs that have occurred in superconductivity research, they look a lot more probable than they did only a year ago.

The discovery of high-temperature superconductivity in a new class of materials is the most important scientific development in the last fifty years, perhaps even more important than the invention of the transistor, the integrated circuit, or the laser. The interest and excitement it has generated in scientific circles is extraordinary. And the speed at which new discoveries are being made has fired the imagination of the general public as well.

Even high-school students have succeeded in producing superconducting materials and have demonstrated the superconducting properties in magnetic levitation experiments such as that shown in Fig. 1. (You can experiment with superconducting materials too! See Don Lancaster's "Hardware Hacker" elsewhere in this issue for more details on the subject.)

## A change of pace

Superconductivity was first discovered in 1911 by Dutch physicist Kamerlingh Onnes. He found that when mercury is cooled to a temperature of 4 Kelvin (that's 4 degrees above absolute zero, or −460°F), it loses all of its resistance to the flow of electricity and becomes a perfect electrical conductor.

For 75 years, research into the phenomenon of superconductivity yielded more than one thousand superconductive substances. The maximum temperature at which a substance becomes superconductive—the *critical temperature* or $T_C$—did increase linearly with time as new superconductors were discovered. But, although the increase was steady, it was at a very slow pace. As late as April 1986, the record for the highest critical temperature belonged to Niobium-Germanium ($NB_3Ge$), a substance that was discovered to have a $T_C$ of 23 Kelvin sometime in 1973.

*We would like to thank Gerald Present, Ph.D., Senior Communications Specialist for IBM Corporation for his contributions to this article.

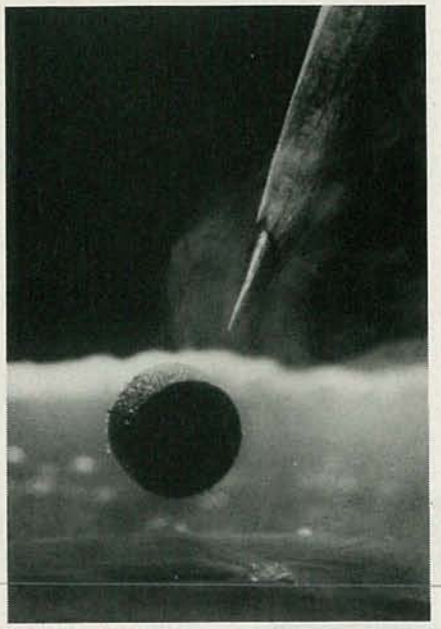


**FIG. 1—A SUPERCONDUCTOR FLOATS IN air above a magnet. This experiment, which has come to symbolize the breakthroughs in superconductivity, demonstrates Meissner's effect, whereby magnetic flux does not enter a superconductive material. In effect, the superconductor looks like a "magnetic mirror."**

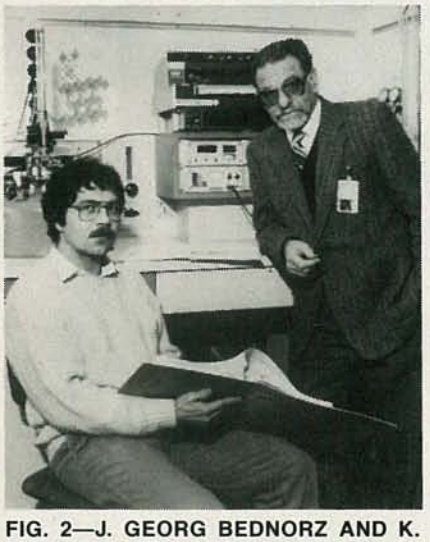


**FIG. 2—J. GEORG BEDNORZ AND K. ALEX MUELLER at IBM's Zurich Research Laboratory provided the spark that ignited the excitement of the world scientific community by their discovery of high-temperature superconductivity in a class of oxide materials.**

A generally accepted theory, the BCS or *B*ardeen-*C*ooper-*S*chrieffer theory suggested that there was an upper limit to $T_C$ at about 40 K. But two scientists at the IBM Zurich Research Laboratory put an end to that way of thinking. They discovered in early 1986 that a new class of materials exhibits superconductivity at temperatures much higher than anyone had ever seen.

The discovery, by K. Alex Mueller and J. Georg Bednorz, who are shown in Fig. 2, has kicked off a flurry of scientific activity around the world. The critical temperature has jumped sharply and, as shown in Fig. 3, dramatic increases in $T_C$ have been coming at an astounding pace. Headlines in the popular press have proclaimed that superconductivity at room temperatures is not only possible, but around the corner!

Only time will tell whether we will ever reach that milestone. But at this time we have already passed an important point along the way: the liquid nitrogen barrier.

Finding a material that superconducts above the boiling point of liquid nitrogen (77 K) is so important because liquid nitrogen is so cheap—a fraction of the cost of the liquid helium that must be used when working with the lower-temperature superconducting materials. Superconductor applications will no longer be limited to such areas as high-energy physics research and oil exploration where the expense and inconvenience of cooling by liquid helium can be justified. Many common electrical applications could benefit, including electric-power generation, transmission, and storage; high-speed rail transport, computers; and electronic instruments as well.

## Superconducting materials

Before the recent discoveries, *intermetallic* compounds (such as niobium-tin, niobium-germanium, etc.) were the best superconductors. But Mueller and Bednorz had become convinced that no further progress would occur in raising the critical temperatures of such compounds. Their insight led them to metallic oxides. The Zurich researchers were very familiar with those oxides and believed they were candidates for higher-temperature superconductors.

For high superconducting-transition temperatures to occur in a material, either the number of electrons available to carry current must be high or the attractive or coupling forces between the electron pairs responsible for superconductivity must be strong. Even though oxides have fewer available electrons than metals (which generally make good superconductors), some metallic oxides were already known to be superconductors, although only at temperatures of up to 13 K. That could only imply, the researchers reasoned, that the materials had particularly strong electron-pairing forces. They thought they could find even stronger pairing forces in oxides of nickel and also copper.

After much work on a number of different systems, they become aware of a class of copper oxides that was reported to behave like a metal in conducting electricity. Those materials had not been studied previously for possible superconductivity, but Mueller and Bednorz believed they were perfect candidates.

In January 1986 they found a strong decrease in electrical resistance when they cooled the material, a ceramic copper oxide containing lanthanum and barium. By April, their best samples showed a transition occurring at 35 K—a very substantial increase over the 23 K reported for niobium-germanium in 1973. They immediately reported their results and the race was on—a new chapter in physics had begun.

The impact of the IBM discovery on the world physics community was astounding—by January 1987 several other research teams had prepared their own versions of the IBM compound and reported similar results and even higher transition temperatures.

Paul C.W. Chu, a leading superconductivity researcher from the University of Houston, found that by pressurizing a superconducting oxide, he could raise the critical temperature to 70 K. He theorized that the pressure helped increase the critical temperature by bringing the layers of copper and oxygen and lanthanum and barium closer together. He found another way to bring the layers closer: He replaced the barium with strontium, which is a similar element but has a "smaller atom." That raised the critical temperature even more. When Chu replaced lanthanum with the element yttrium, the composition of the substance was altered drastically—and the critical temperature shot up to 95 K. He announced his results on January 29, 1987, and started a revolution within a revolution. The liquid-nitrogen barrier had been broken.

By the time of the March, 1987 meeting of the American Physical So-

ciety in New York, thousands of scientists and engineers throughout the world were trying to understand more about the new class of oxide superconductors, to find variations that had still higher transition temperatures, and to explore possible applications.

Shortly after that, IBM researchers made the first thin films of the new higher-temperature superconducting material, which led to the development of the first superconducting devices to operate in the liquid-nitrogen range. The device, called a SQUID or *S*uperconducting *QU*antum *I*nterference *D*evice, is an extremely sensitive magnetic-field detector.

## It's not easy

Despite all the truly fantastic discoveries and developments, there are still problems to overcome. But researchers seem intent on overcoming all of them.

For example, one of the major problems with the new superconductors was their low *critical current*—the current above which a material loses its superconductive properties. But researchers changed things in record time. IBM researchers reported that the materials were inherently capable of carrying 100,000 amperes-per-square-centimeter at liquid-nitrogen temperatures—more than 100 times more current than previously believed. Shortly after, Japan's NTT Ibaragi Telecommunication Laboratory reported producing a superconductor able to conduct 1.8 million amperes-per-square-centimeter!

Being able to *consistantly* produce materials with such high critical currents is still a problem. The first isolated single crystals were grown by IBM scientists, who were able to show that the superconducting properties of the materials are stronger in certain special directions of the single-crystal specimens. The current can vary by as much as a factor of 30 depending on its direction in the crystal. That property, called *anisotropy*, might partially explain why typical samples of the new material, which are generally composed of a multitude of tiny crystals oriented in random directions, show low values of critical current.

Another problem with the new superconductive materials is that they are very brittle. It will take much more research to find a way to turn the materials into a type of flexible wire.

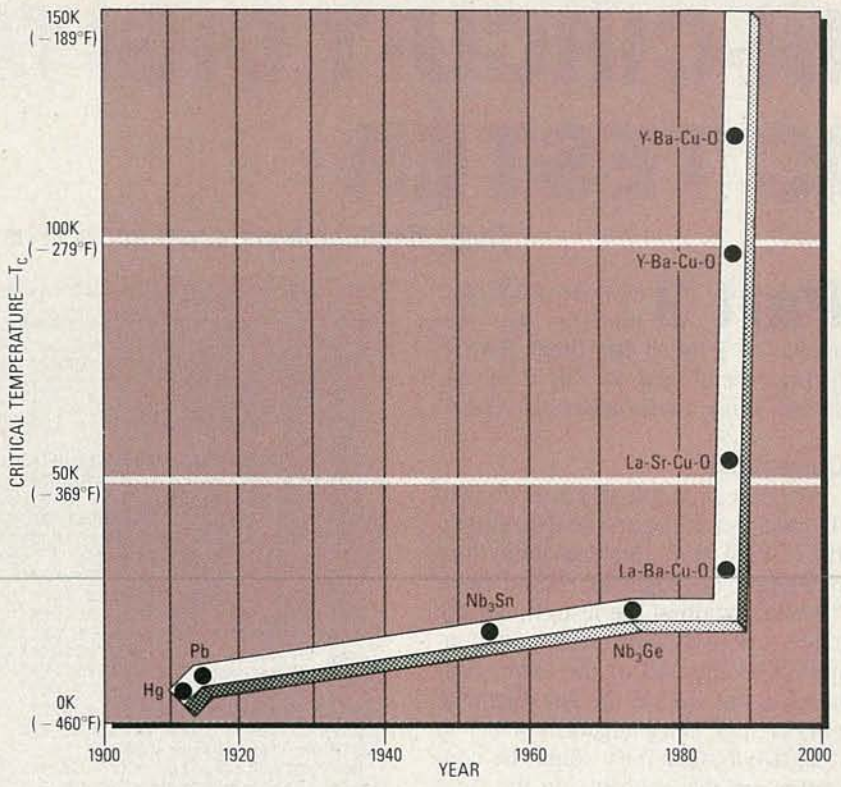



**FIG. 3—AFTER 75 YEARS OF SLOWLY INCREASING as new superconducting materials were found, critical temperatures jumped dramatically with the discoveries of Mueller and Bednorz. While it's not certain that room-temperature superconductivity will ever be achieved, we're certainly heading in the right direction!**

But researchers at AT&T Bell Laboratories are developing coils by filling copper tubing with powdered superconductors. And IBM scientists have shown how plasma spraying, a common industrial technique, can be used to coat even large and complex shapes with superconducting material.

## Applications

The potential applications for high-temperature superconductors are far-reaching. Even if critical temperatures do not increase over what they are today, the new superconductors will change our world.

For example, fusion power could become economically competitive years down the road because the superconducting electromagnets required to contain the fusion reaction will cost much less to produce and maintain than the magnets used in today's test reactors.

The tremendously expensive MRI (*M*agnetic *R*esonance *I*maging) machines that are currently giving medical doctors detailed internal views of the human body will also become much more affordable because they will be cooled by liquid nitrogen. The images will also become many times more detailed as the magnets became more powerful.

Supercomputers will become smaller, faster, and therefore will be more powerful.

But just imagine what would happen if room-temperature superconducting materials could be developed. In short, the world as we know it would change dramatically. Trains levitating on a magnetic cushion as they travelled quietly and pollution-free at speeds better than 300 miles per hour would become a reality. Power-generating plants could be located far from population centers, as lossless power transmission would become a reality. Power plants would even become good neighbors as they generated safe, pollution-free power using fusion or magneto-hydromagnetic technology.

Tremendous progress in superconductivity has been made in a very short time. And you can be sure that there are many other applications of superconductors yet to be discovered. Until 1986, it was generally believed that room-temperature superconductivity would never occur. Now we're asking not *if* that event will happen, but *when*. **R-E**

# IN-CIRCUIT DIGITAL IC TESTER

BILL GREEN

*Three BASIC listings, some corrections, and more!*

**Part 3** DUE TO SPACE LIMitiations, we were unable to publish the three BASIC listings mentioned in Part 2 of this series. Those are shown on this page.

### Corrections

We have a couple of corrections to the first part of the article (November, 1987). First of all, the end of the third paragraph on page 48 should read, "When installing the test clip on the cable, orient the clip so that the connector on the end of the cable connects to the side of the test clip with pin 1 on it. When using a clip with less than twenty-four pins, align the connectors so that the pins on the right end of the clip—the end furthest from pin 1—are even with the right end of the connectors."

Second, on page 48 the next to last paragraph should read, "For example, ERROR PN01 GRP 1 EXP/RD 0100 would indicate a problem with pin 1 in test group 1; a "1" was expected where a "0" was read.

### New kit

Alpha Electronics (P.O. Box 1005, Merritt Island, FL 32952-1005, 305-453-3534) has decided to offer a minimum parts kit for the IC Tester. It includes the PC boards, the non-volatile RAM with code, and the three custom IC's—75498, 75499, and 75500. The cost is $140.00, postpaid in the U.S.; FL residents must add appropriate sales tax. **R-E**

**LISTING 3**

```
000 'THIS PROGRAM (ENTERTST.BAS)
015 'ALLOWS GENERATION OF TEST FILES
020 'ON AN EXTERNAL COMPUTER
025 'FOR TRANSFER TO THE IC TESTER.
030 'by ALPHA Electronics Corporation,
035 'PO Box 1005, Merritt Island, FL. 32952
100 CLS
105 PRINT"ENTER INFORMATION AS PROMPTED FOR GENERATING 'part number.FIL'"
110 DIM A$(256):DIM TF$(8):GRP=1
120 FOR X=1 TO 256:A$(X)="00":NEXT:PRINT 'initialize array to 0
130 PRINT"PART NUMBER MUST BE HEX (0-9, A-F), 8 DIGITS MAX."
140 INPUT"ENTER PART NUMBER ";TF$
150 IF TF$="" OR LEN(TF$)>8 THEN  140
160 IF LEN(TF$)<8 THEN TF$=TF$+"0":GOTO 160 'stretch to 8 digits
170 PRINT"NUMBER OF PINS MUST BE EVEN NUMBER(S) FROM 4 TO 24"
180 INPUT"ENTER NUMBER OF PINS ";NP$
190 IF NP$="" THEN 180:IF LEN(NP$)>2 THEN 180
200 IF LEN(NP$)<2 THEN NP$="0"+NP$ 'stretch to 2 digits
210 NP=VAL(NP$):OFFSET=(24-NP)/2 'offset when less than 24 pins
220 IF NP<4 OR NP>24 THEN 180
230 NP=NP-2:IF NP=0 THEN 250
240 IF NP=-1 THEN 180 ELSE 230
250 NP=VAL(NP$):X=OFFSET+1
260 PRINT"ENTERING DATA FOR GROUP ";GRP:PN=1
270 PRINT"FUNCTION MUST BE I,O,D OR X"
280 PRINT"ENTER FUNCTION OF PIN  ";PN;:INPUT;PF$:PRINT
290 IF PF$="I" THEN A$(X)="02":GOTO 340
300 IF PF$="O" THEN A$(X)="01":GOTO 340
310 IF PF$="D" THEN A$(X)="03":GOTO 340
320 IF PF$="X" THEN A$(X)="F0":PD$="00":GOTO 350
330 GOTO 270
340 PRINT"ENTER HEX DATA FOR PIN ";PN;:INPUT;PD$:PRINT
350 A$(X+24)=PD$
360 X=X+1:PN=PN+1:IF PN<NP+1 GOTO 280
370 GRP=GRP+1:IF GRP=6 THEN 420
380 INPUT"DO YOU WISH TO ENTER ANOTHER GROUP (Y/N) ";Q$
390 IF Q$="N" OR Q$="n" THEN 420
400 IF Q$="Y" OR Q$="y" THEN 410 ELSE 380
410 X=(OFFSET+1)+((GRP-1)*48):CLS:GOTO 260
420 CLS:PRINT"TEST DATA FOR ";TF$;" HAS BEEN ENTERED.  ";
425 PRINT"CREATING FILE ";TF$+".FIL"
430 FOR N=1 TO 8:TF$(N)=MID$(TF$,N,1):NEXT
440 FOR N=1 TO 8:PART$=PART$+"0"+TP$(N):NEXT 'stretch to 16 ASCII digits
450 PINS$="0"+LEFT$(NP$,1)+"0"+RIGHT$(NP$,1) 'stretch to 4 ASCII digits
460 OPEN TF$+".FIL" AS 1 LEN=512
470 FIELD 1, 480 AS B$,16 AS BPART$,4 AS BPINS$,12 AS BFILL$
480 C$=""
490 FOR X=1 TO 240
500 C$=C$+A$(X)
510 NEXT
520 LSET B$=C$
530 LSET BPART$=PART$
540 LSET BPINS$=PINS$
550 LSET BFILL$="000000000000" 'stretch to 512 bytes
560 PUT 1
570 CLOSE
```

**LISTING 1**

```
010 'THIS PROGRAM (SENDTEST.BAS)
015 'SENDS TEST FILES TO THE IC TESTER
020 'by ALPHA Electronics Corporation,
025 'PO Box 1005, Merritt Island, FL. 32952
100 INPUT"ENTER NAME OF TEST FILE TO SEND ";TF$
110 IF LEN(TF$)<8 THEN TF$=TF$+"0":GOTO 110
120 PRINT"SENDING ";TF$;" TO COM1"
130 OPEN TF$+".FIL" AS 1 LEN=1
140 FIELD 1, 1 AS B$
150 OPEN "COM1:1200,N,8,2,CS3000,BIN" AS 2 LEN=1
160 FIELD 2, 1 AS C$
170 FOR X=1 TO 512
180 GET 1,X
190 LSET C$=B$
200 PUT 2,1
210 NEXT X
220 CLOSE
```

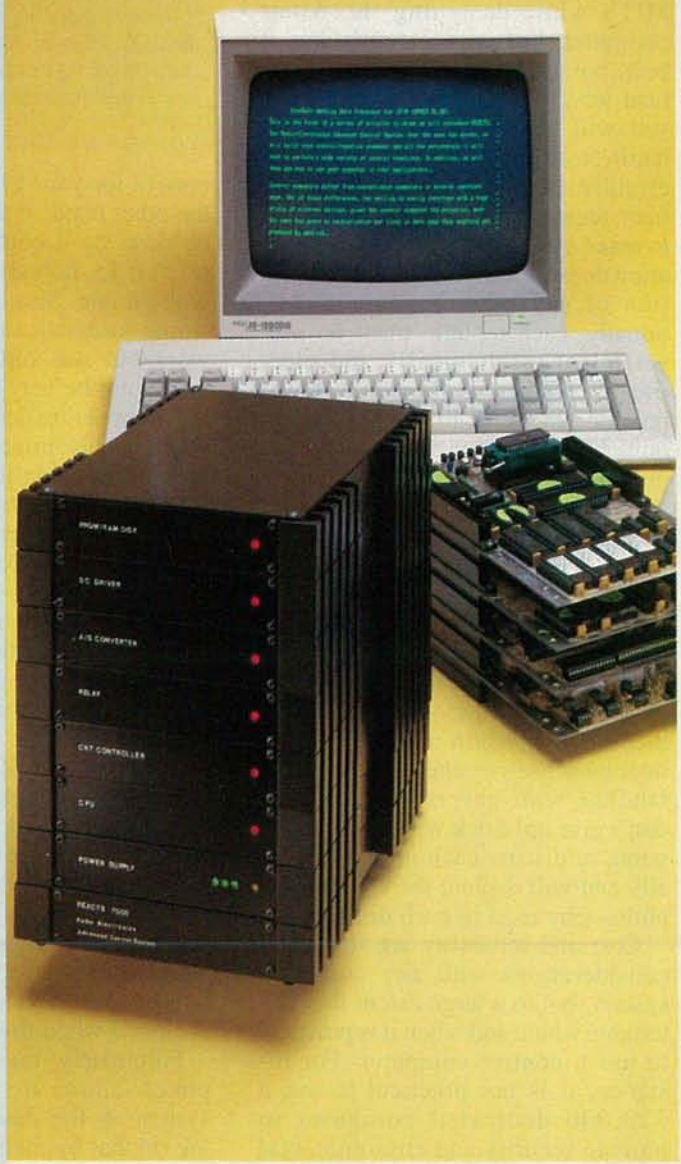
**LISTING 2**

```
010 'THIS PROGRAM (RECVTEST.BAS) RECEIVES
015 'TEST FILES FROM THE IC TESTER
020 'by ALPHA Electronics Corporation,
025 PO Box 1005, Merritt Island FL. 32952
100 INPUT"ENTER NAME OF TEST FILE TO RECEIVE ";TF$
110 IF LEN(TF$)<8 THEN TF$=TF$+"0":GOTO 110
120 PRINT"RECEIVING ";TF$;" FROM COM1"
130 OPEN TF$+".FIL" AS 1 LEN=1
140 FIELD 1, 1 AS B$
150 OPEN "COM1:1200,N,8,2,CS3000,BIN" AS 2 LEN=1
160 FIELD 2, 1 AS C$
170 FOR X=1 TO 512
180 GET 2,1
190 LSET B$=C$
200 PUT 1,X
210 NEXT X
220 CLOSE
```

# Radio-Electronics ADVANCED CONTROL SYSTEM

*A complete, sophisticated control computer that is capable of operating almost every appliance or system in your home, and more!*

H. EDWARD ROBERTS, M.D.



THIS IS THE FIRST IN A SERIES OF ARTICLES IN WHICH WE WILL introduce REACTS, the *R*adio-*E*lectronics *A*dvanced *Con*T*r*ol *S*ystem. Over the next few months, we wi!l build a control/robotics computer called the REACTS 7000, which is based upon the DataBlocks, Inc. *Altair II* system, a complete line of modular control elements currently available for personal and industrial-control computers. We'll also build all the peripherals the computer will need in order to perform a wide variety of control functions. In addition, we will show you how to use your computer in *real* applications.

## Control computers

Control computers differ from conventional computers in several important ways. One of those differences, the ability to easily interface with a huge variety of external devices, gives the control computer the potential, over the next few years, to revolutionize our lives in more ways than anything yet produced by mankind.

In a typical home, there are applications for dozens of control computers. Some simple applications include controlling appliances; adjusting the heating, air conditioning, and/or humidity; minimizing power consumption; and ultimately running a robot lawnmower or vacuum cleaner so you won't have to.

REACTS 7000 is designed to be completely modular, with each module containing the circuitry to perform one or more complete functions. It also uses conventional programming languages (BASIC, C , assembly, etc.). Each subunit or module in the computer plugs into every other module. For example, the first module we will build is the central processor/computer module. That module is a complete stand alone system that includes its own memory, serial port, disk, vectored interrupt, real-time clock, system clock, memory-expansion hardware and all neces-

sary buffers. In other words, it is a complete personal computer. Following that, we will build modules that contain semiconductor disk systems along with integral PROM programmers, complete CRT terminals, A/D converter modules, stepping-motor modules, etc.

The goal of this series of articles is to make *you* the system designer. You do the designing by simply selecting what modules you need for your application. Those modules are then stacked together in any order to create a custom control computer for any application. You need only to pick a language and write the program. Surprisingly, most control applications require simple programs.

Central to REACTS is the soft-hardware concept. Soft-hardware is simply hardware that can be changed or altered as easily as software. The author first developed the concept at MITS while designing the Altair computer, but only recently has it been possible to exploit it in a practical way. Over the next few months you will see how we achieve soft-hardware using straightforward, well-established principles. Indeed, the main requirement for soft-hardware is to make sure that each module's operation doesn't interfere with the operation of any other module. Additionally, each module must be self-sufficient mechanically and electrically, Further, each module should provide shielding to meet FCC requirements, and each module must provide its own motherboard.

## CPU module

The REACTS CPU module consists of a microprocessor, 64K static RAM, 32K EPROM disk system, serial I/O port, vectored interrupt system, completely buffered bus drivers, crystal-controlled clock, 1-megabyte memory-expansion subsystem, and internal sense switches. If you aren't familiar with any of those terms, don't give up! Stick with us as we are going to discuss each item individually and will explore the engineering philosophy used in each decision.

Cost and reliability are important considerations with any computer system, but to a large extent they determine where and when it is practical to use a control computer. For instance, it is not practical to use a $20,000 dedicated computer to provide security and environmental control for your $100,000 home. On the other hand, if the same job could be done by a computer system that sold for $5, nobody could afford to be without one. Similarly, a system that would automatically drive your car to work but was only 99.5% reliable would not be very interesting.

Our goal is to design a machine that is affordably priced and as close as possible to being 100% reliable. That is accomplished by eliminating mechanical subsystems and using special connectors. Cost is controlled, to a large extent, by the soft-hardware concept; you only include what is required for the particular application.

There are some problems along the way with developing an "ultimate" control computer. First, most of us don't have a $250,000 microprocessor-development lab. We have to be able to develop the hardware and software we need on the target system (a target system is the final product of a development project). But, that requires the development of both hardware and software that may only be needed for development and then scrapped when finished.

Fortunately, the soft-hardware approach allows us to use our target system as the development system. We do that by including the development modules (CRT controllers, PROM burners, etc.) during the development stage and then removing the unneeded development modules when finally we install the target system. That approach is especially economical for those who will build multiple systems.

Most board-level computers are designed to work with custom software because that is the easiest to implement. The approach we will take is to use a disk operating system even on the most minimal system. That allows us to use a disk-operating system with all its inherent power. There are a number of disk operating systems from which to choose, but a CP/M-like system is familiar to both MS-DOS users as well as CP/M users. For that reason, we are using the DataBlocks disk-operating system which is a superset of CP/M; indeed, all standard CP/M software will be compatible with our system.

Included in the operating system are all the utilities needed for development, such as drivers for the PROM programmer, drivers for printers, debug routines, etc. Those special utilities can be left out of the final target system if desired, to minimize system size and cost.

## Design principles

The following discussion will give you an idea of the design concepts used in engineering REACTS. It will also give you a feel for the tradeoffs made in the design of the system.

The microprocessor used in the CPU module is a version of the Z-80. That is probably the most popular and widely used microprocessor ever made. It has become the standard in the control industry, and more personal computers have been built using it than any other microprocessor. It isn't the fastest of the microprocessors—indeed some of the newer high-performance microprocessor systems will out-perform it by a factor of 20 to 1. But of the modern microprocessors it is the easiest to understand, and it does not have any unpredictable or "funny" interfacing quirks. That is especially important to the non-expert designer. As we proceed, you will see how we get around the processor-speed problem by using the principle of distributed processing; that is the use of multiple processors in a single system. The multiprocessor concept is based on the assumption that com-

### Sources

The following items are available from DataBlocks, Inc., 579 Snowhill Road, Glenwood, GA 30428. Or call (800) 652-1336; in Georgia call (912) 568-7101: DP-CPU—design package of schematics and instructions, $10.00; PC-CPU—PC board for CPU module (includes DP-CPU design package,$37.00; PC-CLK—PC Board for clock, $18.00; SYS-PROM—the REACTS operating system (enhanced SB-80) installed on a 32K UV-erasable PROM (includes operating system documentation), $44.00; REC-CPU—complete kit of parts, PC boards, IC's, connectors, for CPU module (does not include clock or system PROM), $147.00; REC-CLK—complete clock subsystem including all parts, PC boards, NiCd battery, and connectors, $43.00; and REC-SYS—All of the above, $218.00. An Elpac power supply is also available for $49.00. Please add $10.00 postage and handling per order. GA residents must add appropriate sales tax.

puters are free. It turns out that the principle is reasonably valid in practice, since the CMOS Z-80 is less expensive than a number of other IC's in REACTS. We will also use a number of other techniques that will greatly expand the power and capability of the system.

## REACTS CPU

To get an idea of how fast the REACTS CPU module is in terms of control functions, let's look at a simple example. Assume we needed to turn on or off 2000 switches in a predefined manner. The high-speed version of REACTS would be capable of doing that at a rate of 500 times a second, or approximately 1-million switch operations per second.

The microprocessor used is CMOS. Indeed, all components in the module are CMOS. That increases cost, but it makes battery power, either emergency or continuous, easy. In addition, the noise immunity is improved, and less heat is generated so no fans are needed. Further, less-expensive power supplies can be used and the system can be used in relatively confined quarters without the problem of overheating.

The minimum system memory is 64K of static CMOS RAM, but the system will address a total of 1 megabyte. Static RAM adds to the cost of the system, but it does allow for easy battery powering and makes the system more predictable in a multiprocessor and/or control environment. The addressing scheme is straightforward with the exception of the expanded memory. The expanded memory is based on a paging scheme that allows the computer to switch pages of memory 32K bytes at a time. We will discuss some specific uses of that memory in future articles. It is interesting to note that the page-switching system allows the system to operate at effective direct-memory-access speeds of 10 gigabytes per second. As a comparison, if we could read a 40 megabyte disk that fast, it would only take 4 milliseconds to read the whole disk!

A conventional RS-232 port is included in the basic CPU module. That port can be used to connect to a terminal, modem, or any other standard RS-232 device. The baud rate and signal characteristics are under software control and can be modified from within the program.

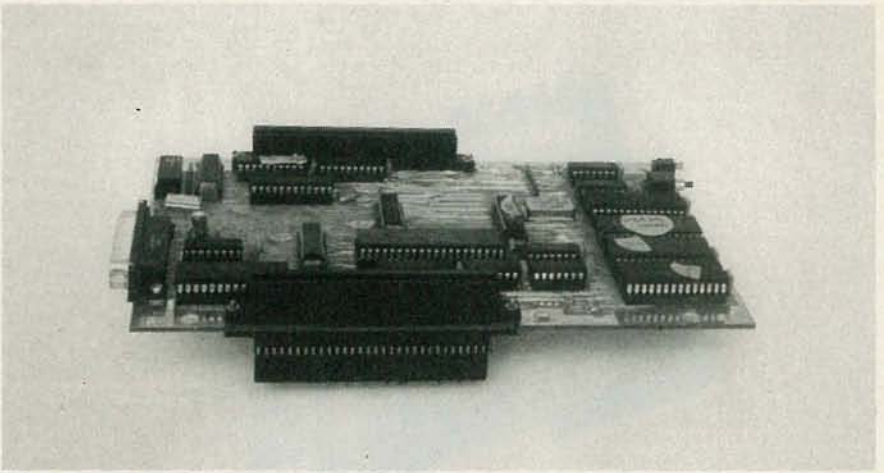


**FIG. 1—EACH MODULE'S MOTHERBOARD interfaces to the REACTS system bus via feed-through Molex connectors.**

The CPU module supports 9-levels of interrupts: one *N*on-*M*askable *I*nterrupt, or NMI, and 8 vectored levels. An interrupt-driven system is especially useful in process control.

There is somewhat of an aura of intimidation associated with interrupts. But actually, they make programming simpler and much faster in many applications. To use an interrupt, you simply pull the line low. That halts the program that is currently running and causes a jump to a special subprogram in memory; its much like a GOSUB command in BASIC. The computer executes the interrupt program and then returns to the original program. Interrupts provide two advantages to the system designer. The first is that the interrupting device can be serviced at random; that is, the program doesn't have to keep checking to see if a service is needed. Second, the interrupt can be serviced instantly; it doesn't have to wait for the main program. Vectoring simply means that the interrupts have levels of priority and that a high-priority interrupt can interrupt a lower priority one. Indeed, it is possible to have a number of interrupts waiting for service in a busy system. In later articles, we will see some detailed examples of practical uses of the interrupt system.

The basic CPU module includes sense switches. Those are simply switches that can be set and read by the program. They are actually a "poor man's" keyboard. An example of where they are useful is in the development vs. target system. In those systems, the computer checks to see the setting of the sense switch on power up, and from that determines whether it should look for a terminal or start executing a program. In a real target system, the sense switches would be used to select which program is loaded at auto start-up.

## REACTS disk

In order to meet our design criteria, even the most minimum system will contain a disk. That is achieved in our system by using a UV-erasable PROM disk. That disk is seen as a disk by both the external hardware and software. It has all the attributes of a write-protected magnetic disk, save one: it operates at blinding speeds. In later articles, we will build larger semiconductor disk systems as well as a PROM programmer that allows you to burn your own PROM disk system for the computer.

REACTS makes extensive use of RAM and PROM disks. Semiconductor disks are significantly more reliable than conventional magnetic disk drives since there are no moving parts. They also consume much less power and are smaller. If large amounts of data need to be stored, then a magnetic disk becomes more attractive. In later articles, we will build a miniature floppy disk that's appropriate for mass storage and that will be compatible with our system. The overwhelming advantage of the semiconductor disk is speed.

The random-access time of a modern high-speed hard-disk system is approximately 25 milliseconds. The random-access time of our disk is approximately 10 microseconds, or approximately 2500 times faster. That is one of the reasons why our system is capable of outperforming some of the bigger and more expensive pro-

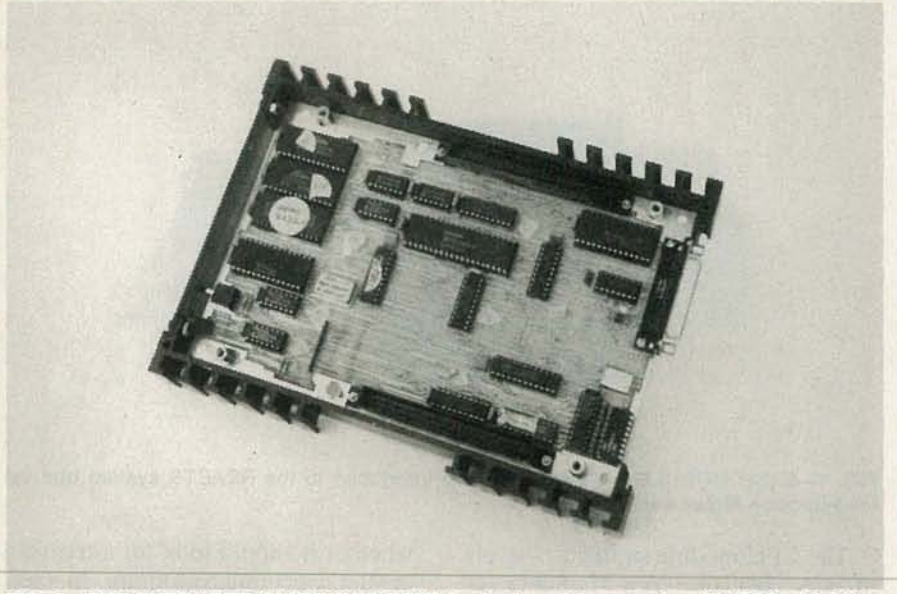
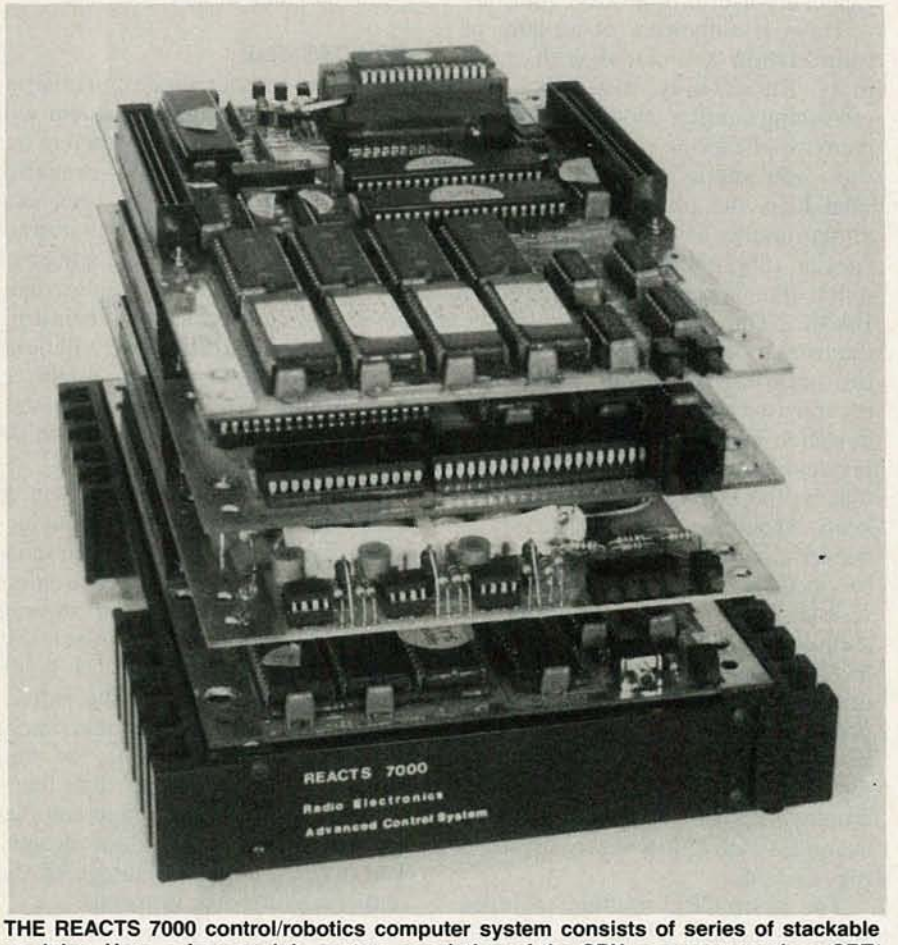


**FIG. 2—THE EXTRUDED ALUMINUM CASE is designed to comply with FCC shielding requirements.**




**THE REACTS 7000 control/robotics computer system consists of series of stackable modules. Here, a four-module system consisting of the CPU, a power supply, a CRT/printer interface and a PROM programmer is shown. The modules are shown out of their shielded cases.**

cessors. Finally, semiconductor disk systems are much easier to understand and much easier to use when designing custom software.

In order to maintain the soft-hardware concept, the REACTS bus is driven by CMOS drivers. No more than 1 or 2 CMOS loads are ever placed on the bus by any one module. That buffer system also allows for disconnecting the processor from the bus. That is a necessary condition in multiprocessor schemes. Buffers are not the most exciting topic, but their proper use is critical in a multi-processor, soft-hardware system so they will be addressed as we procede.

The standard module card is 8 inches by 5.3 inches and connects to the 120-line system bus using special feed-through Molex connectors. See Fig. 1. Those two connectors allow the modules to be stacked together in any order. The bus that we are using is the Altair-II bus developed by DataBlocks. Our system is designed to be fully compatible with all the existing DataBlocks modules and software. At the present time, there are literally dozens of different modules available that use the DataBlocks Altair-II bus.

## REACTS case

Each module can be provided with its own shielded case that meets FCC standards. If you desire, you can mount the finished, unenclosed assembly inside a conductive case, which also meets FCC requirements. Figure 2 shows a module in its extruded aluminum case; note that the rear panel has been removed for clarity. While that case is unique to REACTS, it is compatible with the standard Altair-II system or equivalents.

A word about FCC standards is appropriate at this time. Each builder is responsible to make sure he meets the FCC requirements. All modules in this series of articles are tested to the most stringent FCC requirements using self-contained cases. Nevertheless, it is your responsibility to verify that your system doesn't interfere with any other service.

The real-time clock is plugged into the CPU-module board. That is done to keep cost at a minimum; the clock need only be installed if an application requires it. An on-board NiCd battery is used to provide backup power for the clock. The clock provides time, date, month, year, and can be used to generate interrupts to the main system. We will make extensive use of the clock in some of our future articles.

That's all we have room for this time. When we next meet we continue our look at REACTS and show you how to build the first of our modules, the CPU. **R-E**

**CARL LARON,**
ASSOCIATE EDITOR

# Making your own PC Boards

*This month we debunk some of the myths about making PC boards and show you some shortcuts to success.*

HERE AT **RADIO-ELECTRONICS** WE GET hundreds if not thousands of questions a year on a variety of electronics topics. One of the most common questions, especially from beginning hobbyists, is about PC boards.

That's really not surprising. If you've never done it before, making a PC board can seem like an enormous job. That's why many builders will only undertake a project where a pre-etched PC board is available.

But if you do that you're missing out on a good deal of the fun of building! What's more, etching a PC board is really simple, once you've learned how and have mastered the techniques that are required.

In this article we are going to debunk some of the myths about etching boards. We'll show you that you don't need a darkroom or a camera to use the photographic method. We'll explain the difference between the positive and negative etching systems, and how you can use either regardless of whether you start off with positive or negative art. We'll show you how to make simple PC boards by just drawing right on the copper blank. We'll show you how to make a PC board without etching at all. And we'll name suppliers of PC-board supplies for the hobbyist.

We'll even show you how to use our very own PC Service!

## Making PC boards

The final goal of making a PC board is creating a pattern in copper on a phenolic, glass-epoxy, or similar board. The various methods differ only in the technique used to get the pattern onto the board.

There are three basic steps in making a PC board. They are:

- Create the original artwork.
- Transfer the artwork to the PC board
- Etch the board.

For the purposes of this article, we have assumed that you already have a PC pattern (if you need help in creating a pattern from a schematic, see "Etch your own PC Boards, Part 1" in the December 1982 issue of **Radio-Electronics**). Your next problem, then, is to transfer the artwork to the PC board.

The most popular way to do that is the *photographic method*. It's named that because it uses photographic techniques to transfer the pattern to the copper. That is, a photographic print is made on a photosensitized copper-clad board. The material used

**FIG. 1—PRESENSITIZED PC BOARDS conveniently take a step out of the board-making process.**

**FIG. 2—PHOTORESISTS are available in positive aerosols and negative aerosols and liquids. A negative liquid in a pump bottle from Datak is shown here.**

to render the board photosensitive reacts in such a way when exposed to light that part of the copper is removed when placed in an etchant bath, and part is unaffected.

However, the photographic method does not require an elaborate darkroom, a camera, or any extensive photographic skills. Only a working area away from direct light, some trays, an inexpensive *contact frame* (or even just a piece of glass), a strong light source, a few chemicals, and access to running water. You also need the artwork in a form where it can be transferred to the board; that is called a *photomask*. We'll show you how to make a photomask shortly.

Copper blanks come in two varieties: presensitized and unsensitized. Both types have their advantages and disadvantages. Presensitized blanks (see Fig. 1) are easier to use since they take a step out of the PC-board making process. The photosensitizing material, called *photoresist*, has already been applied to the board for you. However, presensitized boards come in only a limited number of sizes and are relatively expensive.

If you use unsensitized blanks, you must coat them with photoresist (see Fig. 2) prior to transferring the pattern. Applying photoresist to unsensitized blanks is cheaper and gives more flexibility than using presensitized blanks; but the process is tricky to master for beginners and takes time. Apply too much sensitizer and it will run, apply too little and it will disappear during the developing process. And after the sensitizer is applied, the board must be dried either overnight or carefully in an oven.

## Positive or negative

Photoresists come in two varieties—positive and negative. The type of photoresist you use determines whether you are using the *positive* photographic method or the *negative* one.

Photoresist is a plastic resin whose properties change when exposed to light. A negative photoresist toughens when exposed to light; when the exposed board is placed in etchant the copper under the now toughened photoresist is protected while the rest etches away. Therefore, *to create a positive image in copper, the negative method requires that you use a negative image of the foil-pattern artwork.* That's because we want light to reach the copper only at the traces and the pads, and nowhere else.

A positive photoresist breaks down when exposed to light; when placed in the etchant, the copper under the unexposed areas is protected, while the copper under the exposed areas is etched away. Therefore, *to create a positive image in the copper, the positive method requires that you use a positive image of the artwork.* We want to keep light away from the pads and traces.

So which method should you use? It depends on which you prefer, which manufacturers' products you are using, and what form your PC artwork is in. Note, however, that positive photoresist has a limited shelf life; GC Electronics manufactures both positive photoresist and positive presensitized blanks; Vector offers positive blanks only. Negative-method supplies are available from Datak, Kepro Circuit Systems, and GC Electronics.

If you have positive artwork and negative chemicals, all is not lost. *Lithographic reversing film* can be used to convert positive artwork to negative, or vice versa. An added benefit of reversing film is it is relatively tolerant of "weak" artwork (artwork that is not perfectly opaque); that means it can be used to turn a low-contrast positive into a high contrast negative. Reversing film is available from Datak, GC Electronics, and Kepro.

## Exposing the board

Once the board is sensitized it is *light-sensitive*, so it must be handled away from strong light sources to avoid exposing it prematurely. But you don't need an absolutely light-tight darkroom. In fact, some manufactures suggest that a 40-watt incandescent lamp, placed a few feet away, makes for an ideal work or *safe-light*. That may not hold true for all sensitizers, so follow the manufacturers' recommendations.

The next step is making a photographic exposure. To do that you need a strong light source. Note that different sensitizers react differently to different types of light. Some for instance, react most strongly to ultraviolet, and therefore you should use a sunlamp for best results. Follow the manufacturer's light instructions when selecting your light source.

(**Caution:** Even a short exposure to UV radiation can cause permanent eye damage. Treat sunlamps with respect and **never look directly at a lit sunlamp, or any other source of UV radiation.**)

Place the photomask on top of the sensitized copper blank and put the two under a piece of glass or into a

**FIG 3—TO EXPOSE THE BOARD, place the sensitized blank and the photomask in a contact frame and place under a strong light source.**

**FIG. 4—AFTER EXPOSING THE BOARD, it must be placed in a tray filled with a developer like the one shown here. After developing, the board is no longer photosensitive and can be handled in normal light.**

contact frame. Place the assembly under your light source and expose them, making a *contact print*. See Fig. 3.

Exposure times will vary greatly depending on the nature of the sensitizer, the photomask, and the light source. Follow manufactures suggestions, but be prepared to do some experimentation on your first attempts. Don't despair! After you've made your first few boards and have the hang of the materials you are using, you will be able to consistently produce an acceptable board on the first try without any trouble.

While the board is being exposed, prepare a developer bath. The type of tray you use may depend on the system you are following. Do not use plastic if you are using the negative system; do not use metal if you are using the positive system. Glass is fine for either. Be sure that the tray is large enough to accommodate your board and fill it to a depth of ½- to 1-inch with a PC-board developer like the one shown in Fig. 4.

When the board is exposed, turn off the light source and remove the blank. Place it copper side up in the developer bath and gently rock the tray back and forth. Follow the manufacturers instructions as to developing time; it will, as usual, vary with the materials you are using.

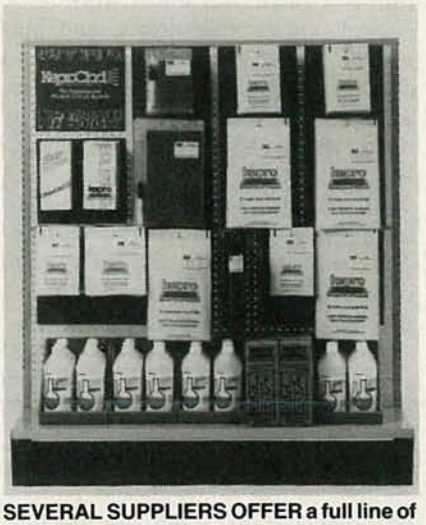
Once the board is developed, rinse it in cool tap water and stand it vertically to dry. Once the board is completely dry it is ready to etch.

The most common etchant is ferric chloride. It is non-toxic, effective, economical, and quick. However, its etching speed slows down as more copper is dissolved. That is not usually a problem for hobbyist applications, but it is something you should be aware of if the board you are etching is very large, or the pattern requires that an abnormal amount of copper be removed. Also, ferric chloride stains clothing and material, so avoid spattering and work in old clothing. Another etchant is sodium persulphate. Available from Kepro, that etchant is a dry crystal that must be mixed with water to be used. It is supplied with a catalyst that provides for a constant etching speed.

Another necessity is an etching tray. Be sure that the tray is large enough to accommodate your board and is made of plastic, glass, or Pyrex, *not* metal (otherwise your tray will etch away as well).

For best results, the etchant should be slightly heated and agitated during etching. Different manufacturers have different temperature recommendations, but they generally range from 90°F to 125°F. Heating can be done with an aquarium type submersible heater or by placing the etchant on a stove burner or hot plate prior to etching. (Again, use a Pyrex tray or pot for that, *not* metal.) However you heat the etchant, be sure that the ventilation in your work area is adequate.

For small boards, simple hand agitation should be adequate; carefully rock the tray back and forth at regular intervals until etching is complete. But while agitating in that way greatly speeds the process, a typical board will still take 20-60 minutes to etch. If you do a lot of etching, you may want to invest in an automatic agitator. Available from Datak, GC Electronics, and others, those range from elaborate systems to simple aquarium-type air pumps terminated with a bubbler to break up the air flow. One automatic agitator is shown in Fig. 5.



**SEVERAL SUPPLIERS OFFER a full line of PC products. Shown here are one company's direct-etch products, presensitized blanks, reversing film, and board-processing chemicals.**

**SUPPLIERS**

**Bishop Graphics**
5388 Sterling Center Drive
Westlake Village, CA 91359

**The Datak Corporation**
65 71st Street
Guttenberg, NJ 07093

**GC Electronics**
Rockford, IL 61101

**Kepro Circuit Systems**
630 Axminster Drive
Fenton, MO 63026-2992

**Vector Electronic Company**
12460 Gladstone Ave.
P.O. Box 4336
Sylmar, CA 91342-0336

**FIG. 5—TO AVOID TEDIOUS HAND agitation, you may want to use an automatic agitator like the one shown here.**

Now, as to the etching itself: Use sufficient etchant to cover the board completely. Place the heated etchant in the tray (or heat the etchant in the tray with a heater) and then carefully immerse the board, pattern side up. Periodically, remove the board, rinse under tap water, and examine the progress of the etching. Once your are satisfied that all the unwanted copper is removed, rinse the board one last time and remove the resist using steel wool or a chemical solvent such as GC Electronic's *Stripping Solution*.

Finally, examine the board in good light and with a magnifier for shorted or open traces, or other defects. Shorted traces can be repaired by scraping the excess copper away with an *X-acto* or similar hobby knife.

Open or incomplete traces or pads can be fixed by touching up with conductive paints or inks, or even solder; conductive paints and inks are available from GC Electronics and others. Once you are sure you have corrected any problems your board is ready for drilling and then for mounting the components.

### Making the photomask

So far things have been straightforward. That's because we've assumed that you had a photomask in hand. Unfortunately, making a photomask can be the most difficult part in PC-board making.

But, as the old proverb says, there's more than one way to skin a cat and the same is true for making a photomask. Let's next look at some of those methods.

If the design is a very simple one, you might be best off using one of the non-photographic techniques that we'll describe shortly. Otherwise, you need to transfer the design to some type of clear film or translucent medium. One way to do that is to use a camera and photograph the artwork. An excellent description of the steps involved in that appeared in "Etch Your Own PC Boards, Part 2", which was presented in the January 1983 issue of **Radio-Electronics**.

Another method is to create a duplicate artwork master using translucent Mylar film and opaque PC drafting aids. That entails first laying out the pattern on 1/10-inch grid paper. Once the artwork is drawn, a Mylar sheet is taped over it, and the pattern is copied using opaque tape, rubylyth film (for large areas of copper such as ground planes), and other drafting aids. See Fig. 6. The result is a positive photomask. Granted, the technique can be tedious and time consuming, but it is certainly a viable alternative for those not equipped with a camera or photographic skills. Suitable drafting supplies are available from Bishop Graphics, Datak, GC Electronics, Vector, and Kepro.

**FIG. 6—YOUR ARTWORK can be transferred to a piece of Mylar film using drafting aids like these. The result is a positive photomask.**

However, some of the products now on the market allow you even easier ways to get artwork onto film, even in cases where there is printing on the reverse side of the original. Datak offers a printed circuit kit that uses an interesting two-step *pos-neg* technique to create a photomask from a printed page. In the first step, specially processed high-contrast film is used to make a *reflex* (reflected) contact exposure. That is, the film is sandwiched between the artwork and a color filter, placed under glass or in a contact frame, and exposed to light. Enough light reflects from the printed artwork to create a low-contrast positive in the film. The low-contrast positive is not suitable for use as a photomask, but the Datak film can be processed by the user to make it act like the revering films we've already discussed. Then, the low-contrast positive can be used to make a conventional contact print on the processed film. The result is a high-contrast *negative*, which can be used to etch a board using the negative method previously described.

Another approach is GC Electronic's *Lift-it* kit. With that system, which is intended for use with printed magazine art, a PC-board image is literally lifted from a page and turned into a photomask. Unfortunately, the magazine page is destroyed in the process. In the system, a sheet of transfer film is applied over the artwork to be copied, sticky side down, and burnished. The sheet is then allowed to soak in warm water for 20 minutes, after which the magazine page is hand-rubbed off and the film is allowed to dry. If everything has gone well, the ink should literally have been lifted off the page onto the film. The sticky side of the film is then covered with Mylar. The result is a positive image of the magazine art.

Another major drawback of the system is that a magazine print often does not contain enough ink to provide satisfactory results. That is, the image produced is not dense enough to use conventional etching techniques. If that is the case, the *Lift-It* image can be used as an intermediate stage and reversing film used to make a high-contrast negative as previously discussed. Those films, such as GC Electronic's *Reversing Film*, can tolerate a weak image very well and still produce a perfectly opaque negative. Making a contact exposure with the film will yield a usable negative photomask, which can be used to etch a board using the negative photoresist system.

**FIG. 7—PC ARTWORK CAN BE DRAWN directly on the copper blank using etch-resist pens. Lacquers and drafting aids can be used, too.**

### PC Service

Some publications, such as **Radio-Electronics** and the *ARRL Handbook* provide PC art on a page with no printing on the reverse side. That allows the printed page to be used as a photomask with little or no additional preparation. In **Radio-Electronics** that artwork is provided in the PC Service section; let's see how to use that art to make a PC board.

The first step is to carefully examine all traces, pads, etc. Printing is an inexact science and imperfections often creep in during the process, especially where thin, closely spaced traces are involved. Examine the art under a strong light or on a light table, and clean up any open or incomplete sections with an etch-resist pen or with PC drafting tape and aids. Shorts and bridges can be scraped away using a knife.

What you now have is a PC-board photomask that, although not as transparent as one on film, will serve nearly as well. You can make the page pass even more light by rubbing the blank side lightly with a small amount of mineral oil. Note, however, that mineral oil blocks ultraviolet light somewhat, so do not use it if your sensitizer is sensitive only to that type of light. Also be careful not to get any oil on the front (printing) side of the page; otherwise you will contaminate the board when you expose it and may get unsatisfactory results.

Once the page is dry, you are ready make the board. Place the mask *printing side down* on a sensitized board (PC-Service art is a mirror image of the actual pattern), place in a contact frame or under a piece of glass, and

*continued on page 70*

# HFBC 87:
# Planning the shortwave bands

*Although HFBC-87 did not achieve its primary objective, decisions taken at the Conference have set the stage for the planning of the shortwave bands.*

**STANLEY LEINWOLL**

THE SECOND SESSION OF THE WORLD administrative radio conference for the Planning of the High Frequency Broadcasting Service—officially designated HFBC-87—was held in Geneva, Switzerland from February 2 to March 8, 1987 under the auspices of the *I*nternational *T*elecommunication *U*nion (ITU), a specialized agency of the United Nations.

655 delegates from 116 countries participated in HFBC-87; its primary objective was to replace the coordination procedures currently being used by shortwave broadcasters with an automated, computer-based planning system under which all countries, large and small alike, would have to share the available spectrum more-or-less equally.

HFBC-87 was a bitterly fought, highly contentious Conference, which on more than one occasion seemed on the verge of collapse. However, an eleventh-hour compromise postponed making a decision for four years (another major high frequency broadcasting Conference has been proposed for 1992), at which time another donnybrook is likely.

A band-allocation plan for shortwave broadcasting has eluded the world's broadcasters for forty years. Major conferences in 1948 (Mexico City), 1949-50 (Florence Rapallo), and 1959 (Geneva) were unable to reach an agreement on how to plan shortwave frequency assignments.

## Planning problems

Rational planning of the shortwave spectrum is a formidable task because the tremendous demand for frequencies exceeds the capacity of the bands allocated to high-frequency (shortwave) broadcasting.

There are a number of reasons for that:

- Shortwave-radio signals are propagated via the ionosphere, an electrified region of the earth's upper at-

mosphere. The range of frequencies that will propagate through the ionosphere depends upon many factors, including time of day, season of the year, sunspot activity, and the relative geographical location of the transmitter and the reception zone, to name just a few.

The ionosphere is in a state of virtually constant flux, and it is extremely difficult to predict accurately which frequency band will provide a reliable service from a particular transmitter location to a given reception area. Because even the most sophisticated prediction methods available are not sufficiently accurate, most broadcasters frequently schedule more than one frequency for the same program going to the same target area.

- Jamming is the deliberate transmission of noise or other harmful interference on a frequency in order to hamper or destroy the programs of a broadcaster operating on that frequency. Since the end of World War II the USSR and its satellites have been responsible for most of the jamming observed in the shortwave spectrum.

Using multiple frequencies is one method broadcasters use to counteract the adverse effects of jamming. The rationale is that the more frequencies used to carry a program, the more difficult it will be to jam all the frequencies. During the height of the cold war in the early 1950's, the Voice of America used as many as 33 simultaneous frequencies to carry a single program. That kind of *saturation* technique has proved to be one of the most effective jamming counter-measures ever used.

Jamming, because of its broadband nature, also hampers broadcasts being carried on adjacent frequencies. Therefore, for each frequency being jammed, three are adversely affected—the one being jammed, and those on either side. It is clear under the circumstances that jamming and rational planning of the shortwave bands are not compatible.

- High-frequency broadcasting is used to serve the national interests of more than one hundred countries. It is the most economical method of reaching tens, even hundreds of millions of people throughout the world. The United States, the Soviet Union, and the United Kingdom alone transmit some 5,000 frequency-hours a day to every continent on earth in virtually every major language.

In addition, many large countries, such as Brazil, Argentina, the People's Republic of China, Mexico, and the Soviet Union, to name only a few, use high-frequency broadcasting to transmit internal, national services.

Because of the versatility of shortwaves, the number of frequency-hours scheduled for shortwave broadcasting since World War II has tripled, and as competition for the limited amount of spectrum grew keener, the standard transmitter power has increased from 50 and 100 kW in the late 1940's to 500 kW used in the 1980's.

Rapidly growing demand for a limited number of frequencies, coupled with the power competition, has resulted in an increasingly chaotic situation in the shortwave broadcasting bands, prompting many countries, particularly the smaller developing countries, to seek remedial measures along several lines.

One is to expand the supply. That is done by re-allocating shortwave frequencies from other services to the broadcasting service. Since the shortwave spectrum is finite (3–30 MHz), such re-allocation is accomplished only after considerable haggling.

In 1979 a major *W*orld *A*dministrative *R*adio *C*onference (WARC-79) was convened. At that Conference, the U.S. proposed to expand the shortwave broadcasting allocation by approximately 50%, all of which was to come from the fixed (point-to-point) services. The developing countries, on the other hand, wanted another planning conference; it was their position that the developed countries were in control of most of the shortwave broadcasting spectrum, and planning was the only way of distributing the spectrum equitably.

A compromise solution was found, and WARC-79 agreed to a 33% increase in the broadcasting allocation, on the condition that a two-session shortwave broadcasting conference be held.

The new channels allocated to broadcasting were to become officially available in two stages: the bands above 10 MHz in 1989, and the 9-MHz band in 1994. Although the U.S. and 21 other nations protested, there was no expansion of the vital 6- and 7-MHz bands.

Another method of alleviating congestion in the high-frequency bands is to plan them. Countries submit their requirements and frequencies are assigned in an orderly fashion in accordance with agreed-upon technical standards (protection ratio, minimum field strength, required signal-to-noise ratio, etc.). When a maximum number of assignments have been made, the unsatisfied requirements remaining are simply deleted.

It is clear that if you are trying to fit a size-11 foot into a size-7 shoe you aren't going to do it unless you use a very painful technique: you cut off the toes. That is essentially what planning is for a great many users. A scarce resource (frequencies) is rationed through a central planning system that distributes frequencies on an equitable basis.

During such an exercise, the requirements of the largest users are reduced. In 1977, the developing and non-aligned countries called for a "New World Information Order" which demanded that the largest users reduce their frequency usage to give the smaller ones access to the broadcasting spectrum.

### International politics

The First Session of the World Administrative Radio Conference for the Planning of the High Frequency (shortwave) Broadcasting Service, called the WARC-HFBC 84, was bitterly fought over the issue of planning. (For more information on that conference, see "WARC-84" in the November, 1984 issue of **Radio-Electronics**.) It finally reached a complex compromise agreement at the eleventh hour which called for the testing of an extremely involved automated computer planning method.

From 1984 to 1986 the *I*nternational *F*requency *R*egistration Board (IFRB), an organ of the ITU, engaged a team of computer experts to develop a computer algorithm and appropriate software required for the shortwave planning system. The most controversial and complicated aspect of the system concerned cases involving incompatibilities—instances in which two or more broadcasters had a requirement for a program to the same target area at the same time in the same frequency band. Since there was not enough frequencies to satisfy all, the IFRB developed a series of "sus-

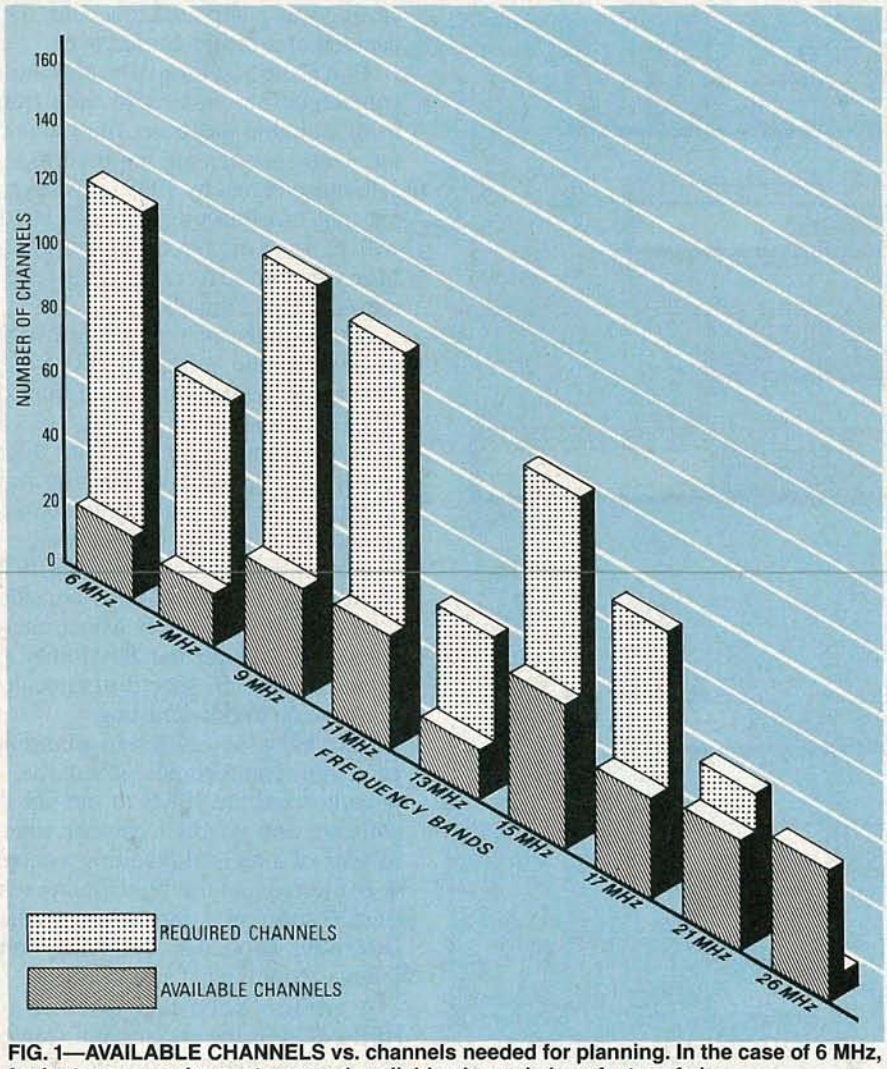



**FIG. 1—AVAILABLE CHANNELS vs. channels needed for planning. In the case of 6 MHz, for instance, requirements exceed available channels by a factor of six.**

pension" rules, in which certain requirements were deleted, and placed in limbo. It was clear that most of those requirements could never be fit back into the plan. Figure 1 is a comparison of the required number of channels with the number of channels available for planning during a one-hour period (1100–1200 UTC). It is clear that requirements far exceed available frequencies.

By the time HFBC-87 opened on February 2, 1987, it was clear that the planning system developed by the IFRB fell far short of most participants' expectations. The first complete plans published by the IFRB showed that approximately 30 percent of all requirements were not satisfied (read "suspended"). Furthermore, a primary broadcasting need for frequency continuity was ignored. As an example, it was not unusual for a single continuous ten-hour requirement to be fragmented among seven or eight different frequencies, with frequent half-hour gaps in which no frequency at all was assigned. The system also reduced many one-hour requirements to half an hour.

Clearly, the test plans were a great disappointment to many administrations. In 1984, at the first session, some 85 countries favored some form of automated planning. After seeing the test plans at HFBC-87, only India, Pakistan, and a dozen Arab nations strongly supported implementation of the new system.

Although it was clear that the system developed by the IFRB was not suitable, many Third-World and nonaligned countries remained solidly behind a commitment to planning, and during the first four weeks of the Conference debate centered around methods of improving the planning algorithm. A number of crucial issues emerged during that period:

- If the Conference was to succeed, the suspension rules would have to be eliminated.
- The lack of frequency continuity in the IFRB algorithm was unacceptable to most administrations.
- There was a serious problem involving national vs. international requirements (55 percent of all shortwave frequencies are used for international broadcasting). The users of shortwave frequencies for national broadcasting fought tenaciously for some form of specialized treatment to protect their services.
- The amount of spectrum available for planning the shortwave broadcasting bands was inadequate.
- The existence of harmful interference (jamming) was a detriment to any attempt to plan the shortwave bands.
- Spectrum conservation techniques, such as the use of *S*ingle *S*ide*B*and (SSB), were essential to improve the effectiveness and the efficiency of the shortwave broadcasting bands.
- Another broadcasting conference would be required to again test the feasibility of planning the shortwave bands.
- The coordination procedures currently in effect would have to be greatly improved.

As the Conference entered its fifth week, working nights and on the weekend, it appeared that the Conference would fail. Debate was bitter and contentious, with some administrations putting forth different compromise proposals, none of which attracted much support. So fractious was the atmosphere that the Chairman of the working group charged with determining what, if any, parts of the spectrum would be planned, resigned angrily and its task turned back to the technical committee.

## Compromise

Finally, the Chairman of the Conference offered a compromise that was acceptable. He proposed that the WARC-79 expansion bands be set aside for testing an improved planning system; in addition, 400 kHz from the higher bands were also set aside for planning. That is shown in Fig. 2. The remainder of the spectrum would be coordinated, with an enhanced coordination procedure to be used.

An integral part of the compromise was that the suspension rules would be eliminated entirely, and that the planning algorithm would be rewritten to include frequency continuity.

On March 3, just five days before

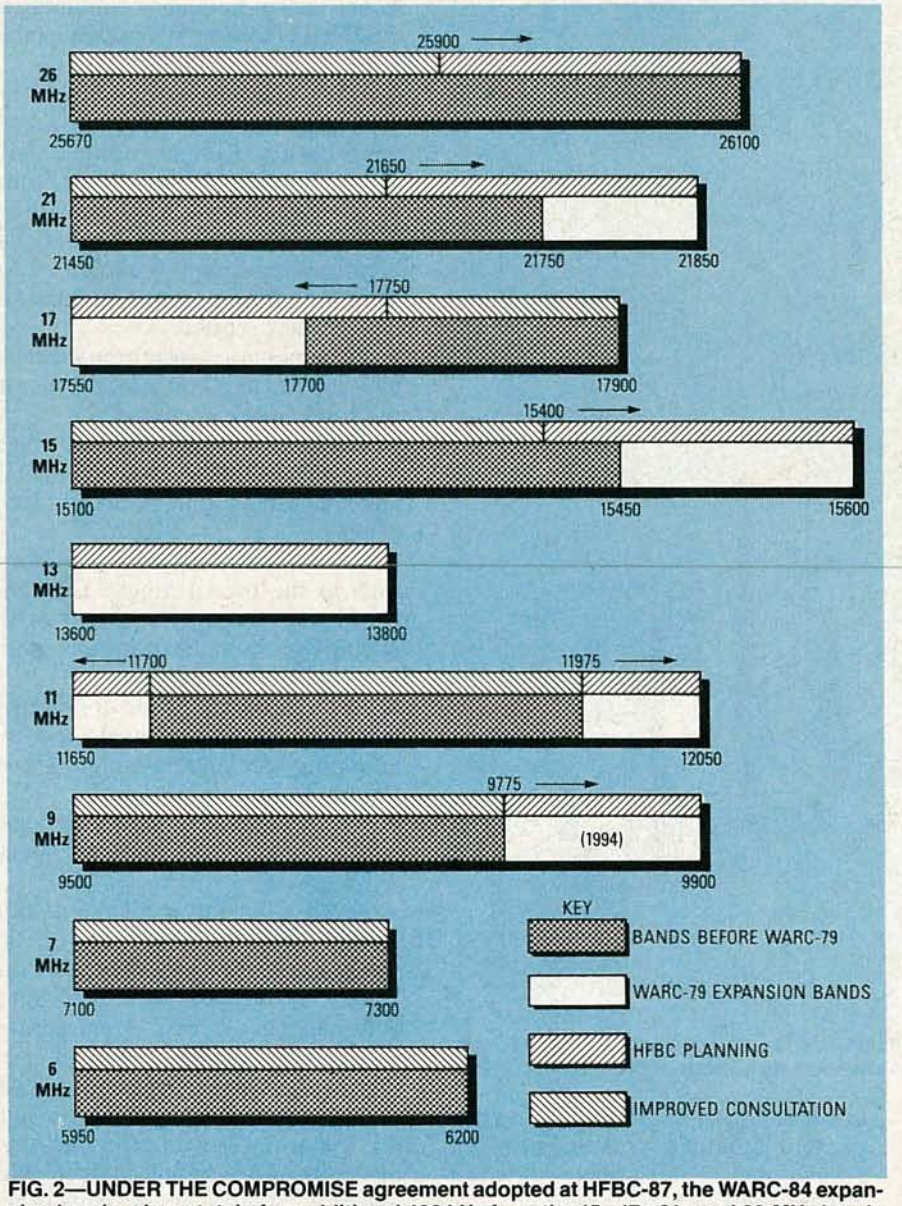



**FIG. 2—UNDER THE COMPROMISE agreement adopted at HFBC-87, the WARC-84 expansion bands, plus a total of an additional 400 kHz from the 15-, 17-, 21-, and 26-MHz bands would be planned. The remainder of the spectrum will be coordinated under Article-17 procedures.**

the end of the Conference, HFBC-87 moved into continuous session, and on the fourth day a broad action program was accepted.

Under that program, the current coordination procedures will remain in effect until the revised HFBC planning system has been tested and reviewed by a future conference.

Under the current coordination procedure (Article 17 of the Radio Regulations), all broadcasters submit their schedules to the IFRB six months in advance of implementation. The IFRB publishes that information in a book, called the *Tentative Schedule*. Where conflicts arise, it is up to the individual countries to solve them. In some instances, the IFRB offers recommendations for resolving the conflicts, but acceptance of those recommendations is not mandatory. The new procedure, in contrast, will leave many of the crucial decisions up to the IFRB.

On March 5, the Conference approved the proposal of the Conference Chairman as a compromise. But one final threat developed:

Pakistan and India submitted a proposal to implement the original planning system in the WARC-79 expansion bands that become available in 1989. There was overwhelming opposition to the proposal and another solution was found. The official date of the WARC-79 expansion bands becoming available for broadcasting was postponed to a date to be decided at a future conference.

That is the first time in history that a conference has agreed to take from itself available spectrum. Inasmuch as the fixed services are required to vacate those bands by 1989, it is apparent that broadcasting in those bands will be on a non-coordinated basis. Many broadcasters have already moved into the bands.

Although the planning controversy dominated the entire HFBC-87, a number of major issues were treated: The Conference:

- renewed the authority of the IFRB to conduct periodic monitoring programs to identify and locate sources of harmful interference (jamming);
- recommended that the ITU's 1989 Plenipotentiary Conference consider scheduling a conference whose agenda would include the possibility of extending the HF spectrum allocated exclusively to broadcasting;
- adopted a set of broad planning principles and technical standards;
- authorized the IFRB to modify its software and conduct another round of tests of a revised planning system;
- requested that the 1989 Plenipotentiary Conference authorize another shortwave broadcast planning conference "not later than 1992".

A major accomplishment of HFBC-87 was the adoption of single- and double-sideband system specifications, as well as a program for the gradual introduction of single-sideband by the year 2016. HFBC-87 approved SSB system specifications, and recommended that any transmitters installed after 1990 be capable of working either on SSB or in both the single- and double-sideband modes.

A number of developing countries expressed concern over the economic consequences of such a transition, particularly concerning the cost of SSB receivers.

Although SSB is an effective frequency conservation technique, its universal acceptance and implementation are far from assured. In addition, the 2016 target date defers for 28 years the benefits that transmission mode affords.

### Give me spectrum, or give me death!

Although HFBC-87 moved closer to the goal of planning the shortwave broadcasting spectrum, many of the

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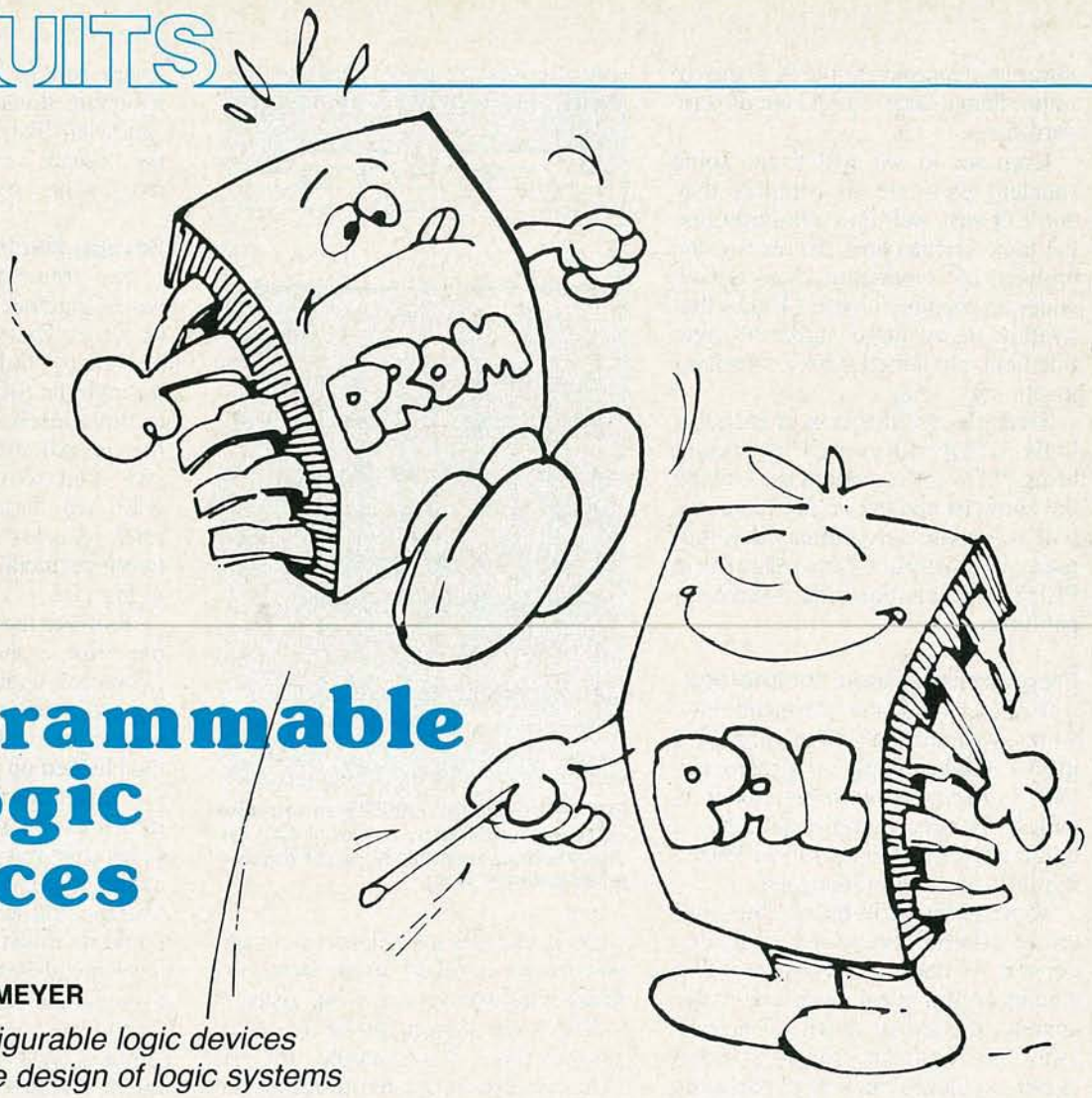



# Programmable Logic Devices

ERNEST MEYER

*The new reconfigurable logic devices revolutionize the design of logic systems*

IF YOUR PROJECT DESIGNS USE 7400-SERIES discrete components for random-logic or state-machine control, you'll probably find that you can simplify both the design and the assembly by merely substituting *P*rogrammable *L*ogic *D*evices (PLD's) for the 7400-series hardware.

Programmable logic devices contain gates and flip-flops, just like regular 7400-series IC's. However, in the 7400 series, which is often considered to be standard parts, the gates and flip-flops are wired together in fixed configurations. On the other hand, PLD's aren't hard-wired; instead, they contain small fuses that are blown or left open to connect their internal gates and flip-flops in any needed configuration.

A PLD's fuses are similar to those used in PROM's (*P*rogrammable *R*ead-*O*nly *M*emories), EPROM's (*E*rasable *PROM*'s), and EEPROMs (*E*lectrically *E*rasable *PROM*'s). Usually, the fuse is blown by addressing the location and applying a high-voltage pulse (12–30 volts, depending on the device) across the fuse while the IC is in its *programming mode*. Most standard PROM programmers can be used to configure PLD's.

Erasable PLD's (like EPROM's and EEPROM's) can be wiped clean and reprogrammed—although the wiping is actually a way of bypassing the blown fuses. In that way, hobbyists can reuse a single PLD for a variety of projects or applications.

Circuit designers have traditionally used PLD's for logic functions that are not generally available in standard off-the-shelf components. If not for PLD's, a large number of conventional IC's would otherwise be required to perform a relatively simple non-standard logic task.

## A lot for a little

Because they provide the circuit designer with an enormous array of user-programmable fuses, recent PLD designs can substitute for dozens of standard parts. Typically, a PLD can replace about a half-dozen standard parts, although the exact number of required PLD's depends on the actual circuit. Without PLD's, the increased number of parts increases the size of the circuit board, which in turn lowers the system reliability while increasing the system's cost.

Because a single PLD replaces a variety of standard parts, manufacturers also prefer them to standard parts because inventory is minimized—the number of different IC's which must be stocked is sharply reduced. Also, the integration of discrete parts into a single device puts all the wiring inside an IC rather than on the circuit board, which means that the board's design is simpler and the logic can run faster.

Programmable logic is therefore an excellent choice in systems where board size, board complexity, system reliability, inventory considerations, or speed is important. Even if no single factor is crucial, their combined weight can easily swing the balance

toward a clean and simple PLD design rather than a large composite of standard parts.

Even so, as we will show, some standard parts are so complex they don't fit very well into a programmable logic architecture. To resolve the problem of complexity, there is now under development hybrid PLD's that contain many large standard-logic functions combined with a programmable logic array.

Since the proliferation of different logic architectures will inevitably bring PLD's into common use by both the hobbyist and the professional, we will look at the extraordinary development of complex reconfigurable PLD's, and examine their diverse capabilities.

## Programmable logic technology

To understand how fuse technology works, we must look at the techniques used for fabricating integrated circuits. *Silicon processing*, as it is called, is very complicated; but a quick-and-dirty description will make it a little easier to understand.

To make a silicon-based chip, wafers of silicon crystal are first processed to make transistors. The silicon crystal itself does not really conduct electricity at all. The transistors are created by doping selected regions of the silicon with phosphorus or arsenic, and metal lines deposited on the wafer connect the transistor sites. The transistors and metal lines are called features.

Simply speaking, each feature is formed on the crystal at the selected locations by spraying a light-sensitive protective chemical, called *photoresist*, in a thin, even coating on the wafer's surface. The wafer is then bombarded with light at selected locations through a precise slide projector. The slide projector (called an *optical aligner*) uses a very small slide, called a *mask*, to screen out the light where it isn't wanted. The chemical decays where the light strikes the photoresist-covered wafer, and is simply washed off, leaving bare silicon at selected locations.

The precision of the optical aligner determines how fine a feature can be made. In the early 1970's, it was difficult to make transistors smaller than 10 microns, Now, transistors can be less than a micron in size, meaning the same-size chip can hold more than 100 times as many transistors. Moreover, as features get smaller, the transistors are packed more densely; hence, the devices can work faster.

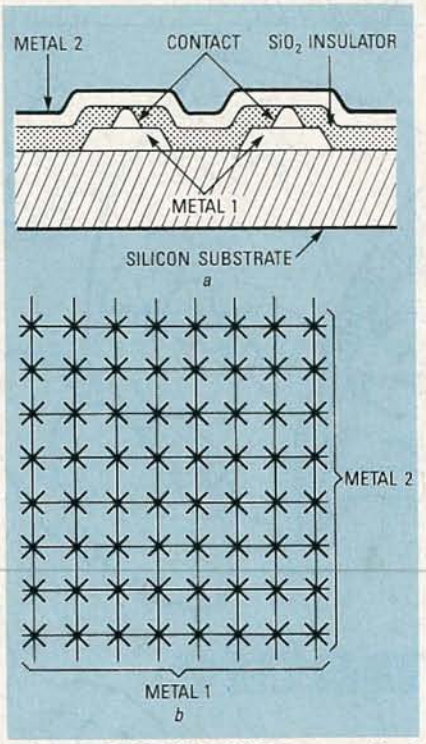



**FIG. 1—THE METAL LAYERS on two-level chips are insulated by a layer of $SiO_2$ (*a*). The first programmable IC (*b*) provided 64 cross-points (fuses).**

The bared silicon can be treated in various ways. For example, the silicon can also be treated to recast the crystalline structure into an amorphous form called *polysilicon*, which conducts electricity and therefore can be used to form wires. Single-level metal chips use polysilicon wires to cross under the metal wires at intersection points. However, polysilicon conducts electricity over a hundred times worse than metal, which substantially degrades performance.

The wafer is heated after the application of each wiring level, which causes the silicon on the surface to oxidize. Since the resultant $SiO_2$ is more bulky than crystalline silicon, the oxide *blooms* over any raised features (such as previously deposited metal lines) during oxidization. Since $SiO_2$ does not conduct electricity, it forms an insulating sheet a few microns thick over the entire wafer surface. The oxide can again be selectively etched: Photoresist is again applied to the wafer, selectively etched away again, and the wafer is exposed to chemicals that attack the $SiO_2$ (but not the pure Silicon) at the chosen feature locations. Further layers can be grown on top of the resultant *planarized* wafer to form a sandwich-like structure, with $SiO_2$ as the "bread," and metal or doped silicon as the "meat."

## Several levels

The transistors on the chip are wired together with deposited strips or spots. The various layers are connected by holes (called *contacts*) through the $SiO_2$ layers. Although up to three levels of metal can be used, the metallization process is expensive, and so IC's are mostly made with two, or even only one, metal level. A cross section of a chip with two-level metal construction is shown in Fig. 1-*a*.

To make the first fuse-programmable chip, as shown in Fig. 1-*b*, eight 12-micron wide horizontal lines were deposited in first-level metal over the bare silicon substrate. The wafer was then heated up to cover the metal with the insulating $SiO_2$. After applying photoresist, sixty four very small holes (five microns in diameter) were etched into the insulator in eight rows over the first-level metal. The contacts could be much smaller than the first-level metal because they just needed to touch the edge of the metal line to provide a conducting path. (Small contacts were necessary for programmable technology, but such contacts greatly reduced the reliability of the device.)

Next, photoresist was applied again to the wafer, and aluminum was deposited in the holes (or *contacts*). Another eight metal lines were deposited in second-level metal, but those were stacked in the vertical direction, crossing over first-level metal at each contact site. The final product was therefore an $8 \times 8$ grid having a very small aluminum contact between each metal-1/metal-2 crosspoint.

Although the contacts—called *fuses*—are made as wide as the wires in standard silicon chips, they are narrower than the wires in programmable logic chips. The interconnecting aluminum is burned away (blown) by applying a very large current across the fuse connection. At lower voltage levels, the fuses that have not been burnt away conduct normally. That is why the metal lines were made so wide and the contacts so small—they had to be made larger than the contacts so that the contacts and not the metal lines would burn away.

## Early PLD's

The earliest programmable chip is the one shown in Fig. 1-*b*; it contained nothing more than a fuse matrix and a wire grid. The crosses represent fuses that can be blown or left open.

The PLD pioneers were quick to stack transistors around the metal grid to make true *programmable devices*. Also, nichrome (nickel-chromium) fuses were used instead of contacts. In that kind of programmable technology, regular contacts are run from the lower metal to the upper metal layer; those contacts miss the actual wire intersection point by 3 microns. A 3-micron strip of nichrome compound is then deposited laterally to connect the contact site to the second-level metal strip. Because of its lower melting point, nichrome fuses out more cleanly than aluminum; in fact, the nichrome actually vaporizes during fuse programming. Therefore, a lower programming voltage is needed, which means that less power needs to be put into the chip. That simplifies programming while making the devices more reliable. Also, the metal lines are not much wider than the fuses themselves, which allows a greater density.

## The PROM

The earliest fuse-programmable device was the PROM. As shown in Fig. 2, PROM input logic (the AND plane) is fixed, while the output logic (the OR plane) is programmable. The upper non-fused fixed-wire matrix feeds a set of AND gates. In the fixed AND array, the output of any one column is high only if all the connected inputs to the column are high. In PROM's, the fixed AND array provides one and only one high output for each possible condition that can exist on the inputs. The non-fused matrix is called a *fixed AND plane*.

The lower matrix is fuse-programmable. Simply speaking, each of the wiring rows feeds into a single enormous OR gate. That description is a simplification, of course, but it is adequate for our purpose.

**TABLE 1**

| $IN_1$ | $IN_0$ | $OUT_2$ | $OUT_1$ | $OUT_0$ |
|---|---|---|---|---|
| 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |

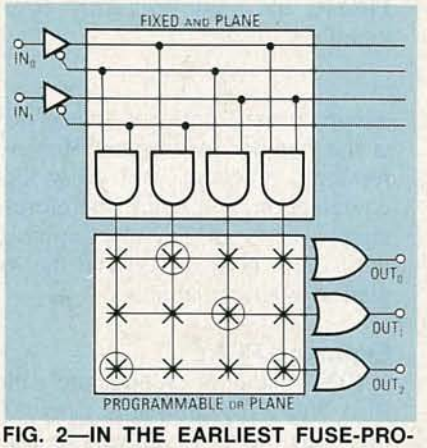



**FIG. 2—IN THE EARLIEST FUSE-PROGRAMMABLE device, the AND plane was fixed; only the OR plane was programmed.**

The OR gate is set so that the output is high if any connected input to the fuse row is high, a configuration that is called a *programmable OR plane*. If the only fuses left connected in Fig. 2 are those indicated by a circled-×, the ones and zeros in Table 1 constitute a truth table for a PROM programmed (blown) with the fuse pattern shown in Fig. 2

Conventionally, PROM's are regarded as programmable memories; however, the devices can obviously be used for logic as well. For example, logic equations can be written for the above device as follows:

$OUT_0 = IN_0$ and NOT-$IN_1$
$OUT_1$ = NOT-$IN_0$ and $IN_1$
$OUT_2$ = (NOT-$IN_0$ and NOT-$IN_1$) OR ($IN_0$ and $IN_1$)

Obviously, $OUT_2$ is a genuine XOR (exclusive-OR) of $IN_0$ and $IN_1$. That may seem like a very clumsy way of making a simple gate, but by expanding the size of the array very complex logic terms can be created. In particular, that kind of architecture is very good for bus-decoding functions. For example, if an 8-bit-wide bus must be decoded in six different ways to provide six enable signals in a

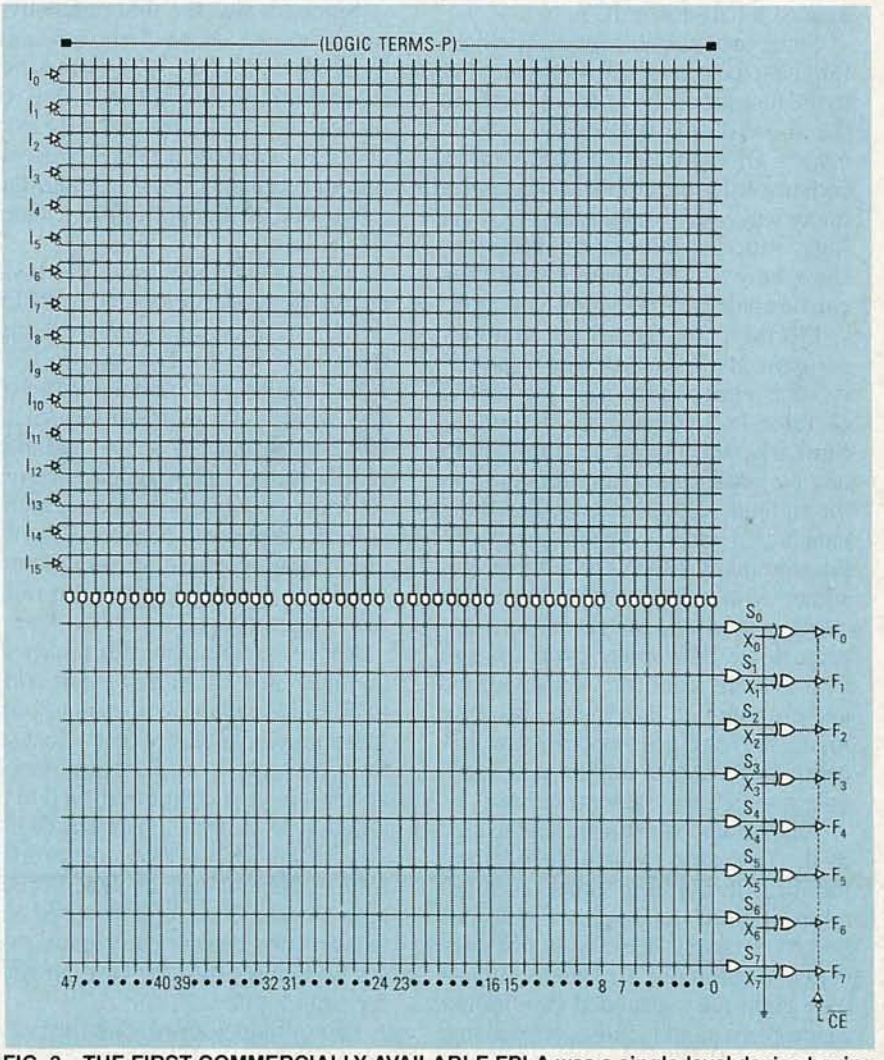



**FIG. 3—THE FIRST COMMERCIALLY AVAILABLE FPLA was a single-level device having approximately 2,000 fuses.**

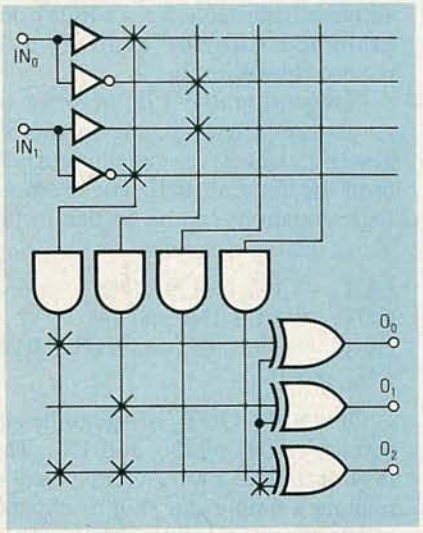



**FIG. 4—IT'S EASY TO IMPLEMENT COMPLEX logic functions in an FPLA. As shown, the functions previously described for a PROM can also be mapped directly into an FPLA's architecture.**

complex digital system (like a computer), one 16-pin device can replace at least a half-dozen IC's.

Since each possible input combination has a corresponding unique input to the fuse array, the fixed AND array in the above device is termed a *full decoder*. Of course, decoders can be constructed from simple logic gates in many ways, but we have depicted the logic structure in an array fashion to show how the AND gates themselves can be made part of an array structure.

PROM's are useful as memory components. When used as a memory, each input combination (on the left of Table 1) is considered an address. Similarly, the output resulting from any particular input combination (on the right of Table 1) is considered the data at that address. In that way, fuse-programmable ROM's provide the designer with a fast, static, long-term storage medium for fixed-data applications. However, even though PROM's are ideal for fixed memory, and even though they can be used for logic, they are not very efficient because they always contain a full decoder, which isn't always needed.

The full decoder increases the size of the fuse array, which restricts the number of possible input connections. To understand that, consider how two signals have four fully-decoded conditions, and three signals have eight fully- decoded conditions. Since every input is fully decoded in a PROM, each additional input doubles the number of fuses required. In a PROM, the total fuse-array size is therefore:

$$2^I \times O$$

where I is the number of inputs and O is the number of outputs. However, for logic functions, not every input combination is crucial; therefore, a simpler and more compact approach is to make both the OR and the AND planes programmable.

## Exploring PLA's

IBM, using an architecture called PLA (for *P*rogrammable *L*ogic *A*rray), was the first company to use a device having both programmable OR and programmable AND planes. In the earliest PLA's, the array was metal-programmed rather than fuse-programmed. In other words, the device was customized during the actual chip fabrication rather than by the chip user, and was therefore used only by manufacturers needing a large quantity of chips.

Signetics was the first company to manufacture *F*use-*P*rogrammable *L*ogic *A*rrays" (FPLA's), which have fuses both in the OR and the AND planes. The first commercially available FPLA, the 82S100 (Fig. 3), was introduced in 1977; it is a single-level metal device having approximately 2,000 fuses.

At the same time, a similar fusing technique was also applied to PROM design, resulting in a rapid movement from 256-bit to 2K-bit PROM's. Also, single-level metal technology was used, with polysilicon for the lower interconnection level and metal for the upper interconnection level. As mentioned earlier, that technique reduces chip cost. In fact, to further reduce chip cost, some vendors now use fuses made of polysilicon rather than nichrome.

Because there is no full binary decoding, each additional input added to an FPLA structure does not double the required number of fuses. Instead, the fuse array is increased in size by an amount directly proportional to the number of vertical channels (which are called *logic terms* or *product terms*). Note, however, that because both non-inverted and inverted signals are provided for each input, there are two inputs into the fuse array for each pin input.

Each product term added to an array allows one additional set of AND products to affect an output condition. Therefore, in the 82S100, there are 48 possible unique AND products that can affect the output. Since the AND-products can be combined together in the OR plane, more than 48 unique input combinations can affect the output. Therefore, three numbers are used when measuring the size of an FPLA: the number of inputs, the number of product terms, and the number of outputs. Those numbers are combined to form the *IPO number*. To calculate the total number of fuses, the number of inputs is doubled (to provide noninverted and inverted inputs to the array), added to the number of outputs, and multiplied by the number of product terms, or:

$$((2 \times I)+O) \times P$$

For the 82S100, the IPO is 16:48:8. The total number of fuses is therefore $((16 \times 2)+8) \times 48$, or 1,920. By contrast, a PROM having 16 inputs and 8 outputs, like the 82S100, would require $2^{16} \times 8$, or 52,488 fuses—more than 25 more.

The smaller size of the FPLA architecture yields four advantages to the logic designer: 1) The array size is smaller, which makes the devices less expensive to manufacture and therefore less expensive to sell; 2) The smaller number of fuses makes programming faster; 3) The reduced array size makes the devices quicker to test; 4) The smaller size of the array makes it possible to make larger programmable devices, which increases their usefulness and power.

## Additional features

Architectural enhancements increase the flexibility of the device even farther. The Signetics 82S100 FPLA, for example, adds two additional programmable features to the basic AND/OR plane.

First, the FPLA can be permanently set to give inverted or noninverted outputs. To achieve the complementary output, the outputs of the programmable OR plane feed into one input of an additional XOR gate. The other input to the XOR gate can be connected to ground. If the grounding fuse is left intact, the XOR gate inverts the output from the OR plane. If the fuse is blown, the input floats high, and the logic signal passes through the gate unaffected. Table 2 shows a truth table for the complementary-output feature.

TABLE 2

| Output from array inverting fuse | | Output from IC |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 1 |
| 0 | X | 1 |
| 1 | X | 0 |

The second feature, three-stated output, is not programmable but greatly improves the IC's usability. If many fuses are left intact in the programmable array, the increased loading slows the device's switching speed. Conversely, if there is a product term with only one or two intact fuses, the output switches much more quickly. As array size increases, the difference in switching speed between the least- and most-loaded gates can produce glitches in the IC's output. Erroneous logic states can be avoided by disabling the outputs until all the signals have settled.

## Using an FPLA

It is easy to implement complex logic functions in an FPLA. For example, the functions previously described for a PROM can also be mapped into an FPLA's architecture. The connections required to do that are shown in Fig. 4.

Four fuse columns were necessary for a PROM, but note from Fig. 4 that the FPLA architecture and complementary output permits only two product terms to be used for the three functions, freeing the other inputs, outputs, and product terms for other logic operations.

## Logic minimization

In Fig. 4, it is relatively easy to work out the connections to use. However, as logic complexity increases, it becomes more difficult to work out which fuse combinations use the product terms most efficiently. When large numbers of logic signals interact, the product-term columns can be tied to different combinations of inputs, and OR-ed together in respectively different ways to generate the same functions. Finding the optimal fuse map through *logic minimization* (the act of reducing logic equations to their most basic form) has two advantages: 1) The danger of running out of product terms is minimized; 2) The number of unblown fuses is minimized, which increases the speed and reliability of the device.

About the time when new software tools were developed to optimize fuse maps, a new development brought about a revolution in programmable-logic philosophy.

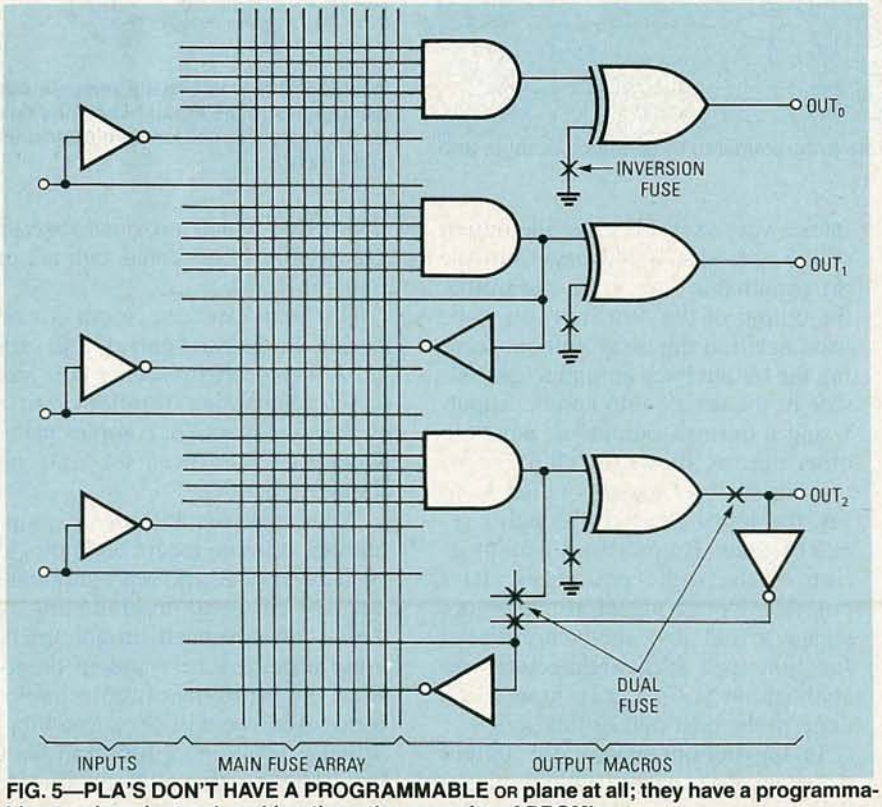



**FIG. 5—PLA'S DON'T HAVE A PROGRAMMABLE OR plane at all; they have a programmable AND plane instead, making them the opposite of PROM's.**

## The PAL

The revolution in programmable logic was the 82S100 PAL (*P*rogrammable *A*rray *L*ogic). PAL's were marketed by Monolithic Memories as a simple alternative to standard parts—the emphasis being on *simple*. To that end, they supplied an easy-to-use programming language called PALASM, a FORTRAN IV program that translates logic equations into a fuse map suitable for use with a standard PROM programmer. At about the time that PAL's were released into the marketplace, 512 × 4-bit (2048-bit) PROM programmers were also interfaced with IBM computers, making it possible for designers to design, document, and program a simple PAL within minutes.

PALASM accepts six distinct data entries as input. First, the PAL part number is entered so that the program knows what sort of fuse map to make. Second, the pattern number is entered, so that the generated file containing a fuse map can be named. Third, the name of the device and the author's name is entered for archiving (so when someone else looks at the file, they know who made it and what it's for). Fourth, a pin list is entered, which contains the symbolic names for the pins that are used in the equations. The symbolic names can be numbers, or signal names like INIT, RESET, NMI, etc. Fifth, the actual equations are entered. A field is left open for the designer to enter notes about the design.

PALASM removes the designer from the world of fuse maps and architectures. However, to use PAL's most efficiently, it is important to choose an architecture that maps on to the type of logic you want to have. Also, PALASM allows designers to generate fuse maps (now often called *JEDEC maps*) directly. But sometimes it is actually easier to type in a fuse map than the equations. Indeed, depending on the needed functions, sometimes it is easier to draw a truth table or a state diagram.

From the architectural point of view, PAL's are easier to use than PLA's because they don't have a programmable OR plane at all: in its place they have a programmable AND plane instead, making them the opposite of PROM's. However, as we'll see very shortly, additional architectural features make PAL's just as flexible to use as FPLD's. As shown in Fig. 5, a

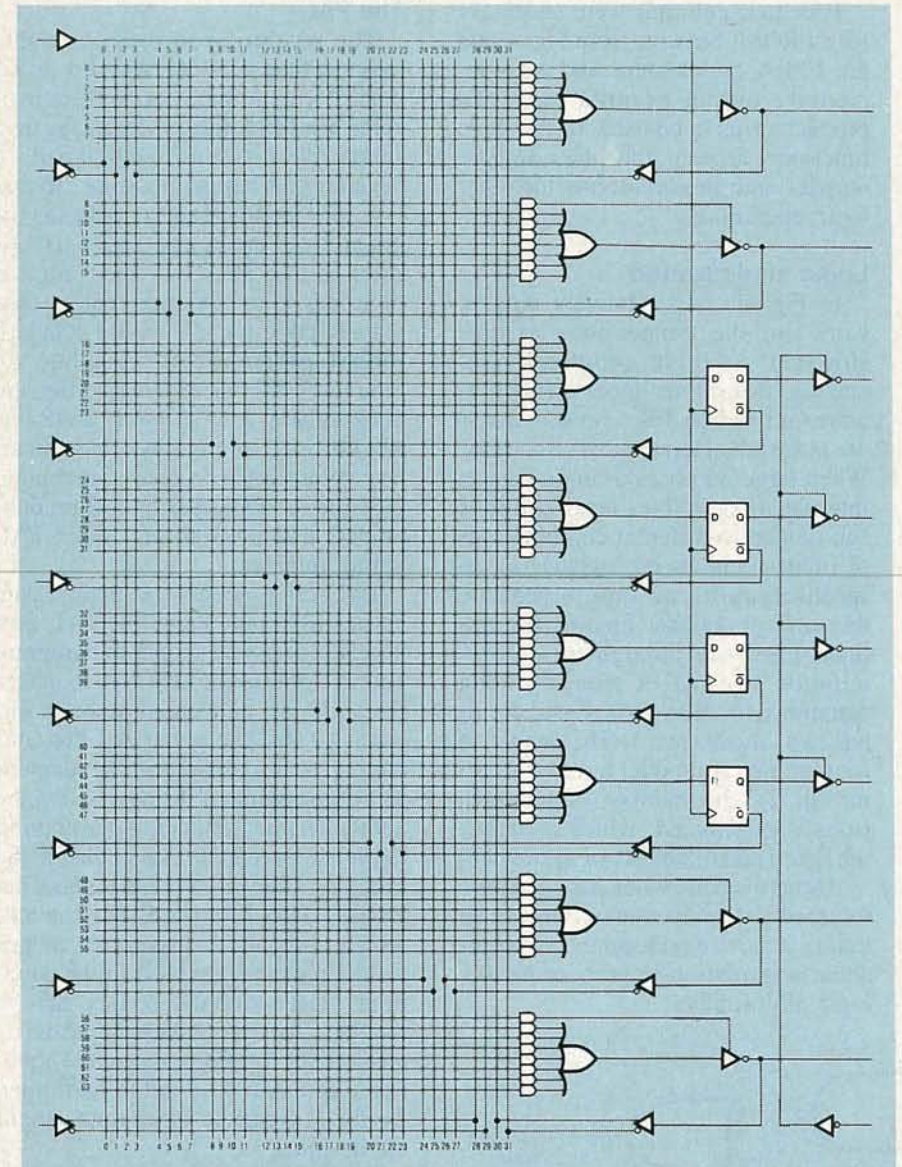


**FIG. 6—THE COMMON PAL16R4 provides fuse-programmable three-stated outputs and four flip-flops.**

PAL's inputs feed directly into the AND matrix.

Figure 5 also shows a new range of functions, called *macros*, at the output of the AND plane. In 1978, programmable logic components came to differ not only in their IPO ratios, but also in their macros, so that picking the best device for a particular application often hinged on choosing the one with the macros that incorporated the needed logic functions for that application.

In the top macro, the AND plane feeds a single AND gate with optional fuse-programmed inversion. That is a very simple macro; and because the inputs to the array are all inverted, we find that the output inversion is not needed at all.

The second macro down incorporates a very useful feature: the output of the AND gate is fed back into the programmable AND plane, permitting the output of the AND function to be used again in the array without feeding the output back around to the outside of the device into another input. Using a macro's outputs as inputs to other macros allows the chip to contain *multi-level* logic—which is to say, the signal can pass through a series of gates. By judicious manipulation of the logic equations, it is possible for an ingenious logic designer to put just about any digital function in a PAL architecture; we shall show you exactly how that's done in the next part of this series.

In the bottom macro, the output driver is replaced by a bidirectional driver consisting of dual fuses. Depending on how the fuses are blown, the macro can be configured as an output or as an input. If the output of the AND gate is broken, but the feedback path and the input driver are left intact, a signal can pass through the input driver and feedback path—however, the AND macro function then cannot be used at that location. On the other hand, if the output of the AND gate is broken and the input driver *is* taken out of the circuit, the AND macro functions normally, and the AND gate function is available for multi-level logic.

It should be obvious that there are a large number of possible macro constructions for combinational logic. However, that is just the beginning. Incorporating sequential logic elements in a PAL opens whole new dimensions of design. In Fig. 6 we see the architecture of the common PAL16R4, which provides fuse-programmable three-stated outputs and four flip-flops.

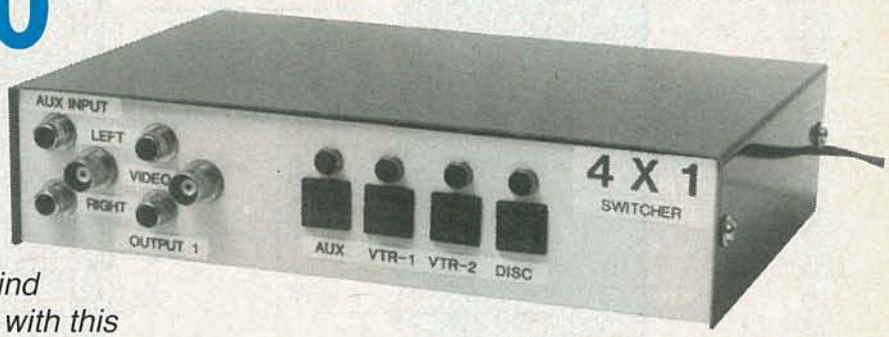
**WHILE PAL's won't really relegate other technolgies to the scrap heap, they do offer the designer another usable and useful alternative.**

That's all we have room for this month. In the next part of this series we will start off by seeing how *macrocells* containing flip-flops can be used for counters, for complex pattern generators, and even for state machines.

After that, we will also explore a number of more recent technologies, such as erasable and reprogrammable devices, universal programming systems, and advanced programmable-logic architectures; and to demonstrate the feasibility of the technology being used, we will show you how to actually program a programmable-logic device with commercially-available software. **R-E**

BUILD THIS

# AUDIO/VIDEO SWITCHER




*Eliminate the mess and confusion of wires that lurks behind your audio and video equipment with this easy to build switcher.*

**TOD T. TEMPLIN**

HAS YOUR VIDEO SYSTEM BECOME OVERrun with a tangle of patch cords, jumper cables, and wires? Do you have to grope around in the restricted space behind your VCR when you want to make a dub? Have you ever wanted to view one program while copying another? If the rat's nest of wires is keeping you from getting the most out of your equipment, then you need the same type of equipment-interconnection system used by professional video operations and television stations. You need an audio/video routing switcher.

We'll show you how to build a 4 × 1 electronic stereo-audio and video crosspoint switcher. It will enable you to select one out of four signal sources (consisting of a video signal and a stereo-audio signal), and connect it to an output bus which can supply an input signal for up to four additional devices. That, of course, can be done by merely pressing a button. You'll never have to touch another cable or jumper again. This device is not a simple mechanical RF-type switcher. This switcher was originally designed to expand the number of inputs on professional videotape recorders and monitors in a commercial television studio. Also, the technical specifications (shown in Table 1) are so good that the device is virtually transparent to any signal passing through it.

**TABLE 1—SPECIFICATIONS**

| | |
|---|---|
| **Audio Section** | |
| Frequency Response | −1, +0dB 30Hz - 20KHz |
| S/N Ratio | 75dB at 5V Input Level |
| Cross-Channel Isolation | 62dB |
| Input Impedance | Greater than 50 Kilohms |
| Output Impedance | Kilohm |
| THD | .07% at 20Hz |
| | .04% at 1KHz |
| | .03% at 20KHz |
| **Video Section** | |
| Frequency Response | DC - 8MHz |
| Cross-Channel Isolation | 70dB |
| Input Impedance | 75 ohms |
| Output Impedance | 75 ohms |
| Differential Phase | −0, +3 degrees |
| Differential Gain | Less than 3% |

Consumer VCR's and monitors rarely have more than one set of inputs and outputs. But consumers often have several signal sources, including a second VCR, a video disc or CD-video player, an image enhancer or noise reducer, or perhaps a special effects generator. If your system has several signal sources and you want to drive more than one monitor or VCR simultaneously, there is no simple way to connect them all together into an easy to use, versatile, and functional system. Just making a simple A to B dub may result in a maze of patch cables, Y-adapters, and double-terminated signals. And, since most VCR's and monitors have their input/output jacks located on the rear panel, getting to the connections can be a difficult and frustrating task.

The 4 × 1 switcher eliminates those problems by allowing all of your audio and video equipment to be connected together in one totally-integrated, "patchless" system. That is accomplished by placing one 4 × 1 switcher at the input of each device that must receive a signal from more than one source, and then connecting each device's output to the inputs of each switcher. Each switcher has a four-output bus, so that any signal can be connected to four devices. Operation of the switcher is very simple. By pressing any one of the switches (S1–S4), the corresponding signal source is connected to the output bus. Because each switcher has a built-in distribution amplifier, up to four loads can be connected to the output bus. The block diagram for the device shown in Fig. 1 clearly shows how the four signal sources are multiplexed to one output bus.

Until recently, it would have been impossible to build a switcher of such

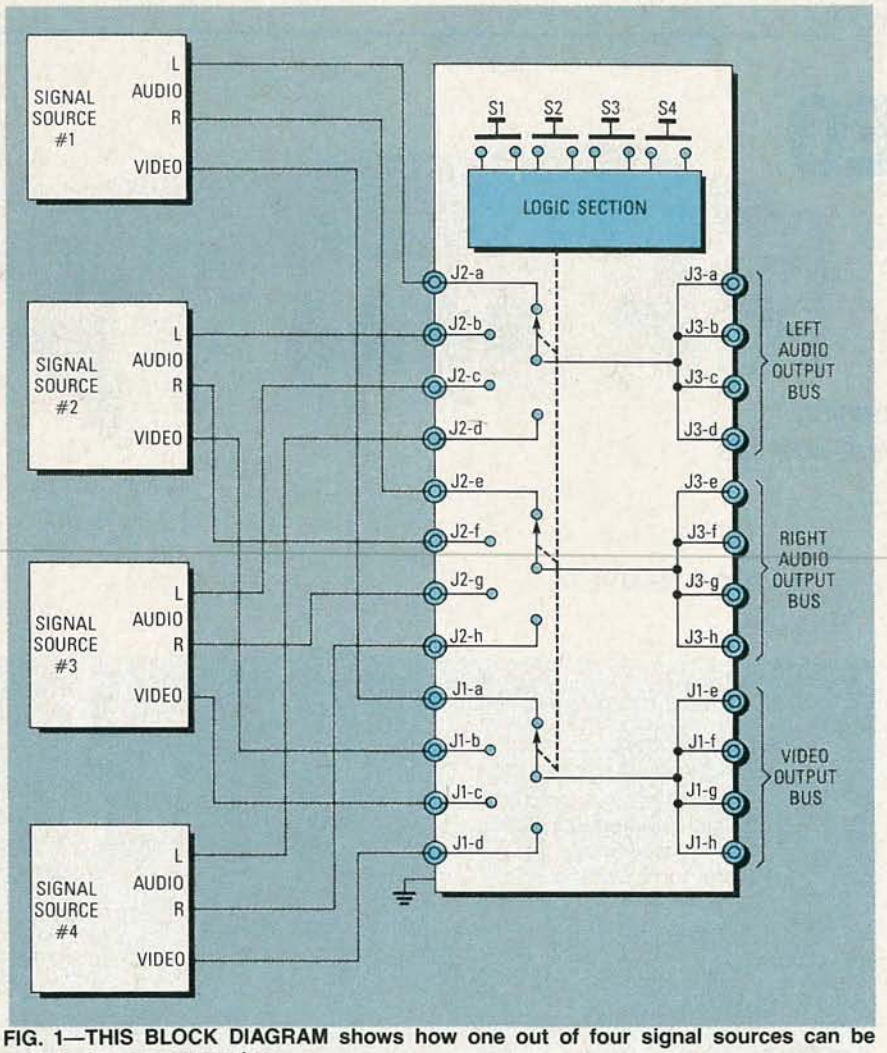



**FIG. 1—THIS BLOCK DIAGRAM shows how one out of four signal sources can be switched to one output bus.**

high quality using so few parts. However, new IC's are now available, which are specifically designed for audio and video switching. The MAX454 from Maxim Integrated Products (510 N. Pastoria Ave. Sunnyvale, CA 95054 408-737-7600) combines a CMOS 50-MHz video amplifier and 4-channel multiplexer in a single package. The TDA1029 from Signetics does the same for stereo-audio signals. It contains two 4-channel multiplexers plus input and output buffer amplifiers designed for audio frequencies.

## Logic circuit

The complete schematic for the 4×1 audio/video switcher is shown in Fig. 2; we'll begin our analysis with the logic section. Selector switches S1–S4 are connected via diodes D1–D8 to the four NAND gates in IC1. Those gates are configured as a cross-coupled SET/RESET flip flop (latch) and a 2-bit *B*inary *C*oded *D*ecimal (BCD) encoder. The outputs of IC1 are connected to the inputs of IC2 (another quad NAND gate), which decodes the latched information from IC1 back to decimal format, where it is used to light the LED of the selected channel and to drive the audio-channel-selector pins of IC5. The BCD information from IC1 is used to drive the video-channel-selector pins of IC3. Note that IC5 requires decimal information while IC3 requires BCD information.

To understand the operation of the logic circuit, suppose you have just pressed S4. A low (ground) signal is routed simultaneously through D7 and D8 to IC1-a and IC1-c. A low on either input of the gate will cause its output to go high, so we now have highs on the outputs of IC1-a and IC1-c. Those high levels are cross-connected to one set of inputs of IC1-b and IC1-d, and the other set of inputs are being pulled high by resistors R2 and R4. That action causes the outputs of IC1-b and IC1-d to go low. Those low signals are again cross connected to the other set of inputs of IC1-a and IC1-c. We now have lows at both inputs of IC1-a and IC1-c, and highs at both inputs of IC1-b and IC1-d. That results in a steady state or "latched" condition in the circuit. The entire sequence, which happens almost instantaneously, also serves to de-bounce the switches. The two high outputs from IC1-a and IC1-b now also appear at both inputs of NAND gate IC1-b, causing its output to go low and light LED4 as well as select channel 4 of the audio switcher, IC5. The outputs of IC1-a and IC1-c also make up a 2 bit BCD "word" which defines the condition of the latch. Because both IC1-a and IC1-c outputs are now high, channel 4 is selected by the video switcher, IC3.

## Audio circuit

The audio section of the switcher is contained entirely in IC5, a complete stereo-audio, 4-channel switcher. Based on information fed to pins 11–13 from the logic section, it selects a pair of inputs and passes them through an on-chip op-amp buffer to the audio-output bus. DC decoupling for the inputs is provided by C11–C18, which also establish the low-frequency cut-off point of the circuit. The outputs are decoupled by C19 and C20. Technical specifications for the audio section include a frequency response from 30 Hz to 20 kHz, a S/N ratio of 75 dB with an input level of 0.5 volts, and a cross-channel isolation of 62 dB. The input impedance is greater than 50K, and the output impedance is about 1K. The total harmonic distortion for the audio section is 0.07% at 20 Hz, 0.04% at 1 kHz, and 0.03% at 20 kHz.

## Video circuit

The video section of the switcher is made up of two IC's connected in a unity-gain feedback loop. IC3 is a 4-channel CMOS video switch which also has an on-chip buffer amplifier. Because IC3 can drive only one 75-ohm load, a wideband power op-amp (IC4) was added to the circuit to increase the number of video outputs. BCD information from the logic section determines which of the 4 inputs is passed via IC3 to IC4. The buffer amp in IC3 is loaded by R11, while R10 and R12 set the entire circuit to unity gain. The output impedance of

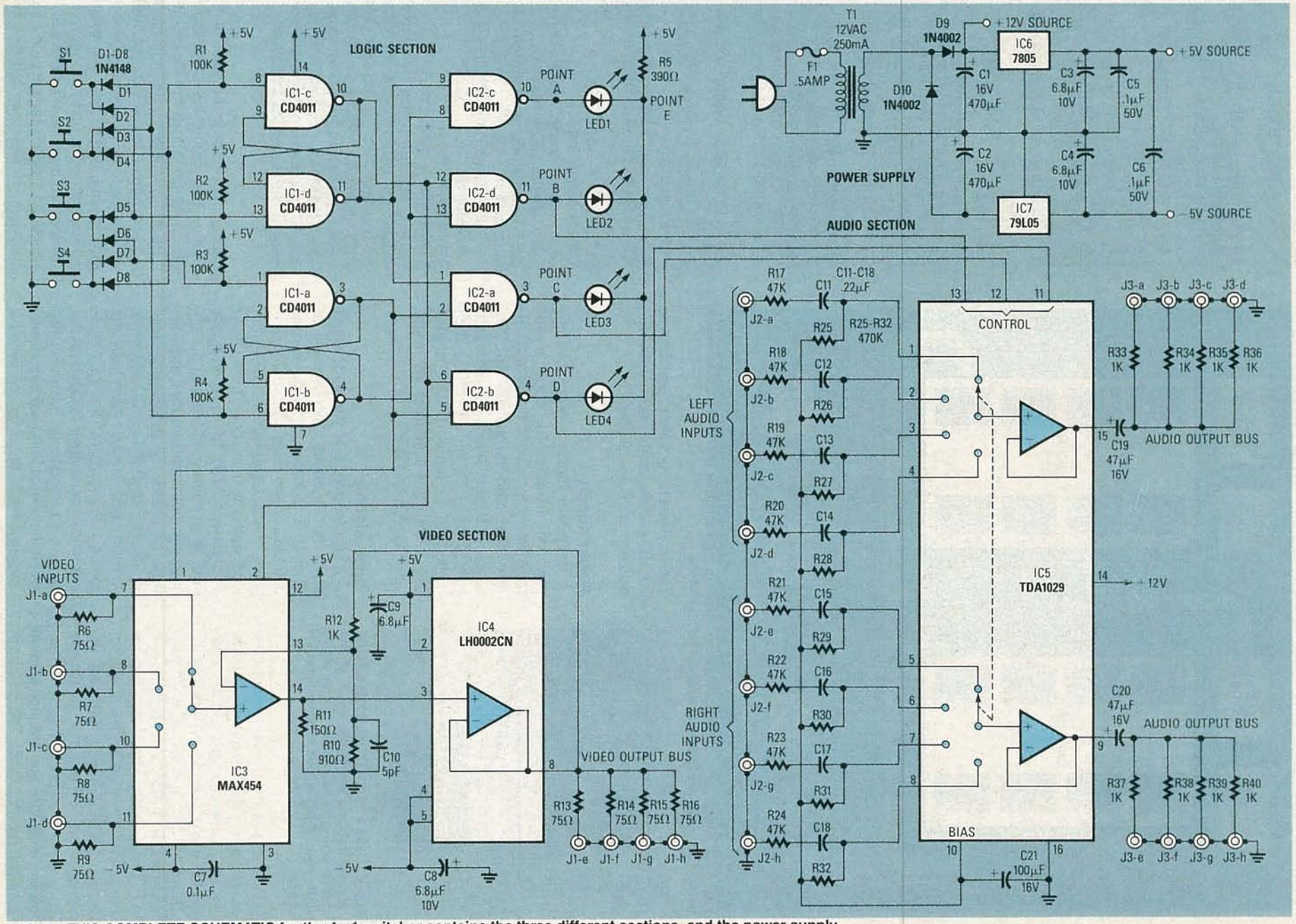



**FIG. 2—THIS COMPLETE SCHEMATIC for the 4×1 switcher contains the three different sections, and the power supply.**

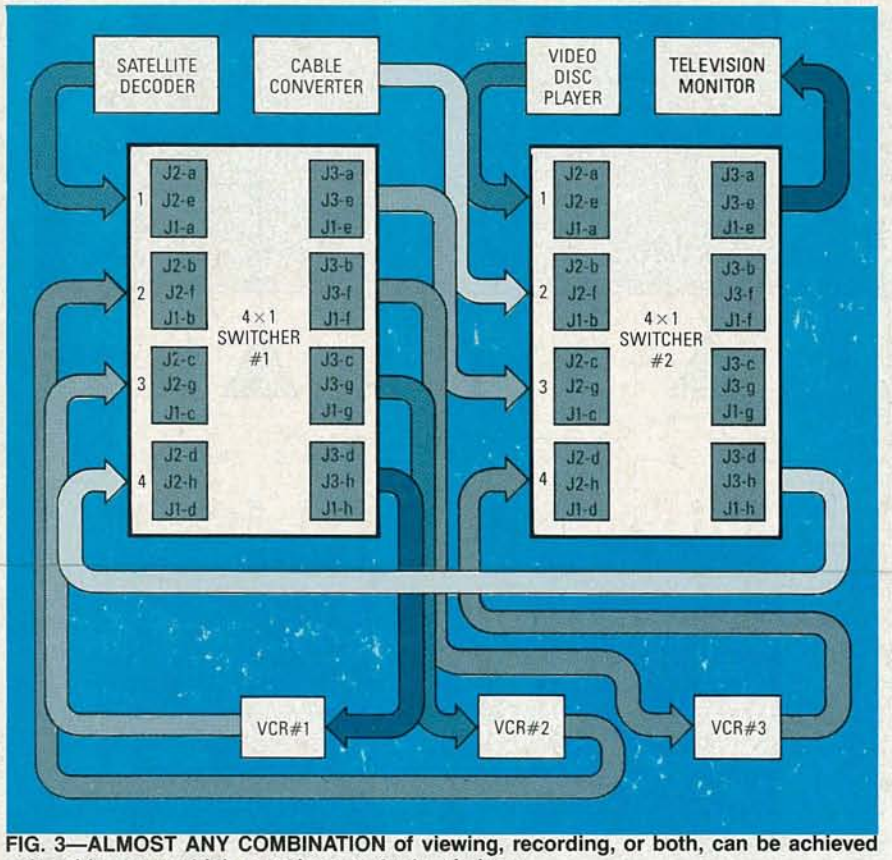



**FIG. 3—ALMOST ANY COMBINATION of viewing, recording, or both, can be achieved using this setup which contains two 4×1 switchers.**

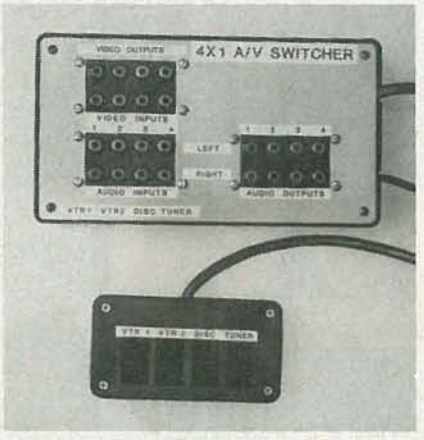



**FIG. 4—THIS 4×1 SWITCHER has a separate control box which allows all of the messy wiring to be hidden out of sight, while controlling it from a convenient location.**

IC4 is so low that its output approximates a zero-impedance voltage source. Consequently, loads connected to the output resistors have no effect on one another. The 75-ohm resistors, R13–R16, establish the correct drive-source impedance for 75-ohm cable as well as short-circuit protection for IC4. C10 establishes the upper-frequency response of the circuit. With C10 being 5 pF, the frequency response for the video section is virtually flat from DC to about 8MHz. The cross-channel isolation is 70 dB, and the input and output impedance are both 75 ohms.

## Power supply

The power supply is not at all complicated. 12 volts AC from a wall transformer is rectified by D9 and D10 into plus and minus 12-volt DC sources. Ripple filtering is provided by C1 and C2, and +12V is then tapped off to supply IC5. The plus and minus 5-volt sources are regulated by IC6 and IC7.

## Video signals

It is important that you understand a few basics about video signals in general. Standard composite video is defined as *1 volt from sync tip to maximum white level*, across a 75-ohm load, and contains signals from DC to as high as 5 MHz. Because of those high frequencies, video signals require special attention; they must always be connected between devices by 75-ohm shielded cable, and must be terminated into a 75-ohm load impedance. If a constant 75-ohm impedance is not maintained throughout the system, an impedance mismatch between the source and load will occur, causing some of the video signal to be reflected back from the load to the source. The visible result of that is reflections or "ghosts" in the picture.

Each 4×1 switcher has four inputs and one output bus. Therefore, only one out of four inputs may be connected to the output bus, and supply an input signal for up to four devices. Chances are that one switcher will be sufficient for the average person's video system. However, by building two

### PARTS LIST

**All resistors ¼-watt, 5% unless otherwise noted**
R1–R4—100,000 ohms
R5—390 ohms
R6–R9, R13–R16—75 ohms
R10—910 ohms
R11—150 ohms
R12, R33–R40—1,000 ohms
R17–R24—47,000 ohms
R25–R32—470,000 ohms
**Capacitors**
C1, C2—470 µF, 16 volts, radial electrolytic
C3, C4, C8, C9—6.8 µF, 10 volts, radial tantalum
C5–C7—0.1 µF, metal film
C10—5 pF, mica or disc (see text)
C11–C18—0.22 µF, metal film
C19, C20—47 µF, 16 volts axial electrolytic
C21—100 µF, 16 volts, radial electrolytic
**Semiconductors**
D1–D8—1N4148 diode
D9, D10—1N4002 diode
IC1, IC2—CD4011 CMOS quad NAND
IC3—MAX454 video switch/amplifier (Maxim)
IC4—LH0002CN power op-amp (National)
IC5—TDA1029 audio switch/amplifier (Signetics)
IC6—7805 positive voltage regulator
IC7—79L05 negative voltage regulator
LED 1–LED 4—red LED's
**Other components**
J1–J3—octal-type RCA jacks, or select jacks to suit needs
S1–S4—SPST momentary push button switch
T1—12VAC, 250 mA, plug-in wall transformer
**Miscellaneous**
1 chassis of your choice
**NOTE: The following items are available from T3 Research, 5329 N. Navajo Ave., Glendale WI 53217-5036: 4×1 PC board, $10.00 postpaid; MAX454, LH0002CN, and TDA1029N (1 of each type), $18.50 postpaid; Wisconsin residents must add 5% sales tax.**

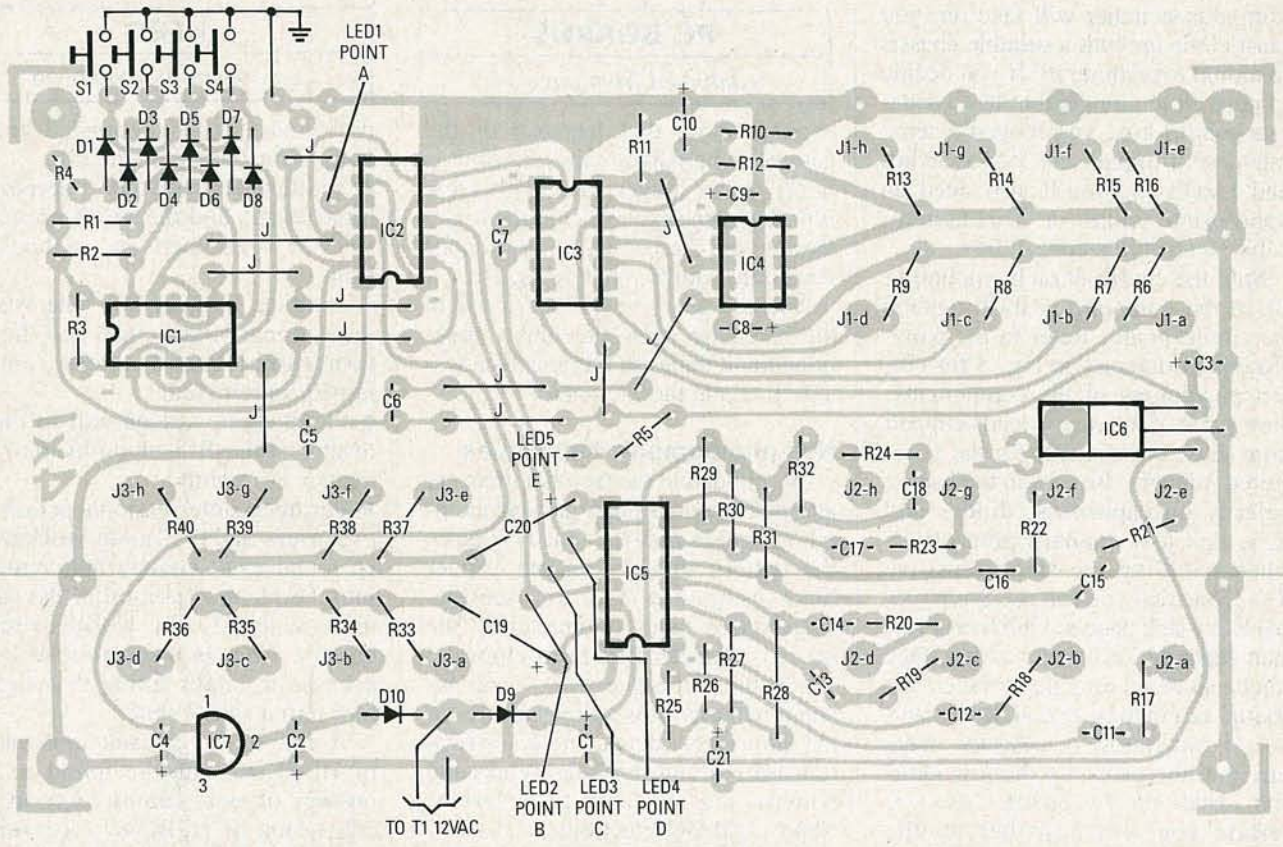



**FIG. 5—REFER TO THIS parts-placement diagram when assembling the PC board.**

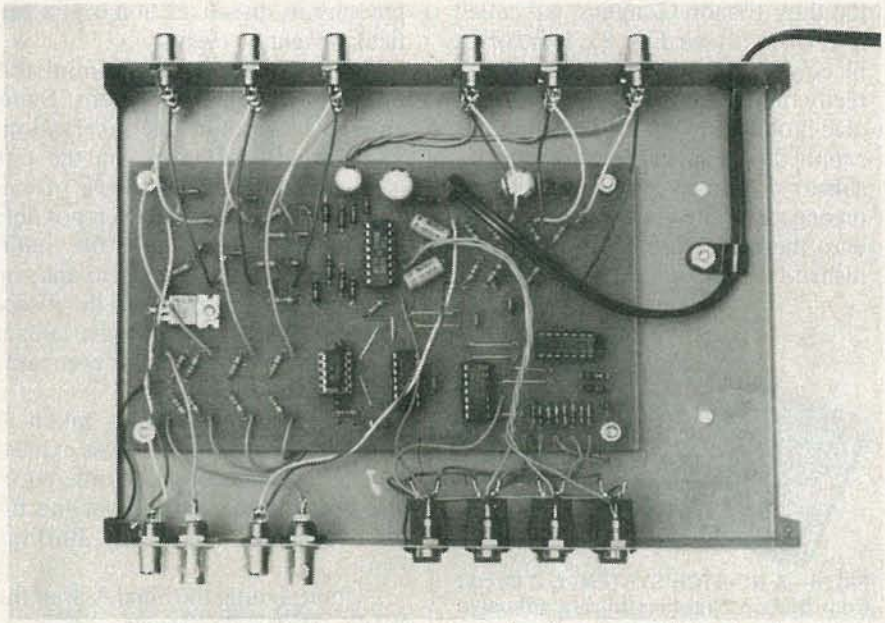


**FIG. 6—YOU CAN MOUNT the completed PC board on the bottom of the chassis, and wire the jacks on the sides as shown.**

or more 4×1 switchers, you can put together a system similar to that in Fig. 3. That system provides for just about any possible combination of viewing, recording, or both. Of course, the number of switchers you'll need and how you wire them together depends on your particular system's requirements.

## Construction

Before assembling your switcher, it's a good idea to sketch out how you want to connect your equipment together. You probably require only one 4×1 switcher. But, if you have a more complex system, make a diagram like that of Fig. 3, to see how many switchers you'll need. During actual construction, you can then install as many switchers as you need in one chassis of an appropriate size. Note that a PC board can be purchased from the source mentioned in the parts list, or one can be made using the foil pattern shown in the PC Service. Remember, you'll need one 4×1 circuit board, and complete set of components for each switcher that you build.

There are two ways that the 4×1 switcher can be assembled. Although they perform identically, they are quite different in concept. In one model, shown in the opening of this article, the circuit board, input/output jacks, and selector switches are all mounted in a conventional chassis. That arrangement brings all of your system's interconnecting cables to wherever your switcher is located. That is certainly fine if you only need one switcher. In the other model, the selector switches and LED's are located in a separate control box and connected to the switcher by a 10-conductor cable, as shown in Fig. 4. In the cable, four conductors and one common are used for the switches, and the same goes for the LED's. That allows the main chassis to be located behind your equipment.

After you decide what configura-

tion your switcher will take on, you must come up with a suitable chassis to mount everything in. If you decide to go with the model that has a separate control box, you'll need a separate case to mount the four switches and LED's in. You'll also need an appropriate length of 10-conductor cable to reach the control box.

Start the construction by mounting all of the components flush against the circuit board. Refer to the parts-placement diagram in Fig. 5 for correct positioning of the components. Save some of the excess leads clipped from those components for the 11 required jumpers. Be certain to observe polarity on capacitors, diodes and IC's, and use standard precautions when handling the static-sensitive IC's. Note that you can use 8-pin (octal) RCA-jack panels, which cost less than separate RCA jacks. Also, they can be soldered directly to the circuit board, eliminating a good deal of wiring. If you choose octal jacks, make sure that the jacks are the *last* items you install on the board. Also, be certain you wire together all the ground tabs on each jack before you solder it down to the board. Leave enough wire on the end tab so that it can reach down to the ground hole on the circuit board.

Once the board is complete, all that is left to do is to mount it in the chosen chassis, and add the appropriate wiring. When finished, it should look similar to the one shown in Fig. 6. (Note that Fig. 6 shows the unit in which everything is contained in one chassis.) It is then ready to be hooked up to your video system and tested. Should any problems arise, go back and check your work.

Normally, if the 4×1 switcher is built totally from fixed-value components, it will perform as indicated in the specification chart, with no adjustments required. However, increasing the value of C10 (in the video section) will cause the video frequency response to tilt upwards. It is possible to compensate for high-frequency roll-off, caused by extremely long cable runs, by replacing C10 with a 5–20pf trimmer capacitor. That creates what is known as an equalizing DA (*D*istribution *A*mplifier). While observing a multiburst test signal, C10 is adjusted for a flat response. Don't be concerned about the problem of roll-off if your cables are less than 250 feet long. **R-E**

## PC BOARDS

*continued from page 54*

expose. Note that because of the nature of the paper, exposure time is likely to be longer than with clear film. Do some experimentation to determine the correct exposure time for your light source, chemicals, etc.

You can also use PC Service with the reversing films previously mentioned and then use the negative system to create the PC board.

### Non-photographic techniques

We alluded to the fact that there are alternatives to the photographic method for simple designs. One is to place the pattern directly on the copper blank using etch-resist ink (see Fig. 7), lacquers, tapes, and patterns. The board is then etched in ferric chloride. While the technique works well for small patterns, it is tedious to use for anything larger than a one-IC or two-transistor circuit. Etch-resist inks and patterns are available from Datak, Kepro, and GC Electronics.

Finally, there is a technique that requires no etching at all. Manufactured by Bishop Graphics and called *E-Z Circuit* (see Fig. 8), it involves placing copper strips, donuts, etc. directly onto a pre-drilled, non-copper-clad prototyping board. The copper is supplied on a super-thin, epoxy-glass substrate that has a special adhesive on one side. The copper is positioned onto the prototyping board and burnished in place.

**FIG. 8—A NO-ETCH SYSTEM, *E-Z Circuit* from Bishop Graphics places adhesive copper strips, pads, and patterns on a pre-drilled prototype board.**

The drawback to the system is that it can't be used to mass produce boards, and that the pattern must be transferred to the board by hand. The system works well, however, especially for smaller layouts and for repairing existing boards, and it is possible to use it to do even the most complicated circuits **R-E**

## HFBC

*continued from page 58*

problems that have hounded broadcasting for forty years persist:

- conflicts between large, developed broadcasters and the smaller less-developed newcomers are at the forefront;
- conflicts between the interests of the national broadcasters and the international broadcasters remain largely unresolved;
- the planning system will still have to address the difficult problem of frequency continuity;
- during the intersessional period between now and 1992 a way will have to be found to fit enough requirements into the planned portion of the spectrum to satisfy the world's broadcasters. That is a formidable task, because it entails fitting that size-11 foot into a size-7 shoe.

A clue to the cantankerous nature of HFBC-87 may be found in the number of *reservations* taken at the conclusion of HFBC-87. A reservation is a statement a country enters at the conclusion of a Conference expressing its dissatisfaction over a particular event or events.

Of 116 participating administrations, 70 entered reservations. Some entered more than one reservation. That largely reflected, on the one hand, the continued wariness of major broadcasters toward even possible partial implementation of the modified HFBC Planning System and, on the other hand, it reflected the disappointment of its principal advocates at the uncertain prospects for even such limited application.

Of all the reservations taken at HFBC-87, perhaps the most expressive of the tone of the Conference, and possibly the outlook for the future, was one entered by Burkina Faso:

"Upon signing the Final Acts of the WARC-HFBC(2), Geneva, 1987, the Delegation of Burkino Faso reserves the right for its Government to take whatever measures it may consider necessary to safeguard its interests in the event that the provisions of this Conference are not respected or that any reservations entered by other Members should jeopardize its broadcasting services.

"Our country or death—we shall prevail!" **R-E**

# PC SERVICE

One of the most difficult tasks in building any construction project featured in **Radio-Electronics** is making the PC board using just the foil pattern provided with the article. Well, we're doing something about it.

We've moved all the foil patterns to this new section where they're printed by themselves, full sized, with nothing on the back side of the page. What that means for you is that the printed page can be used directly to produce PC boards!

**Note:** The patterns provided can be used directly only for *direct positive photoresist methods.*

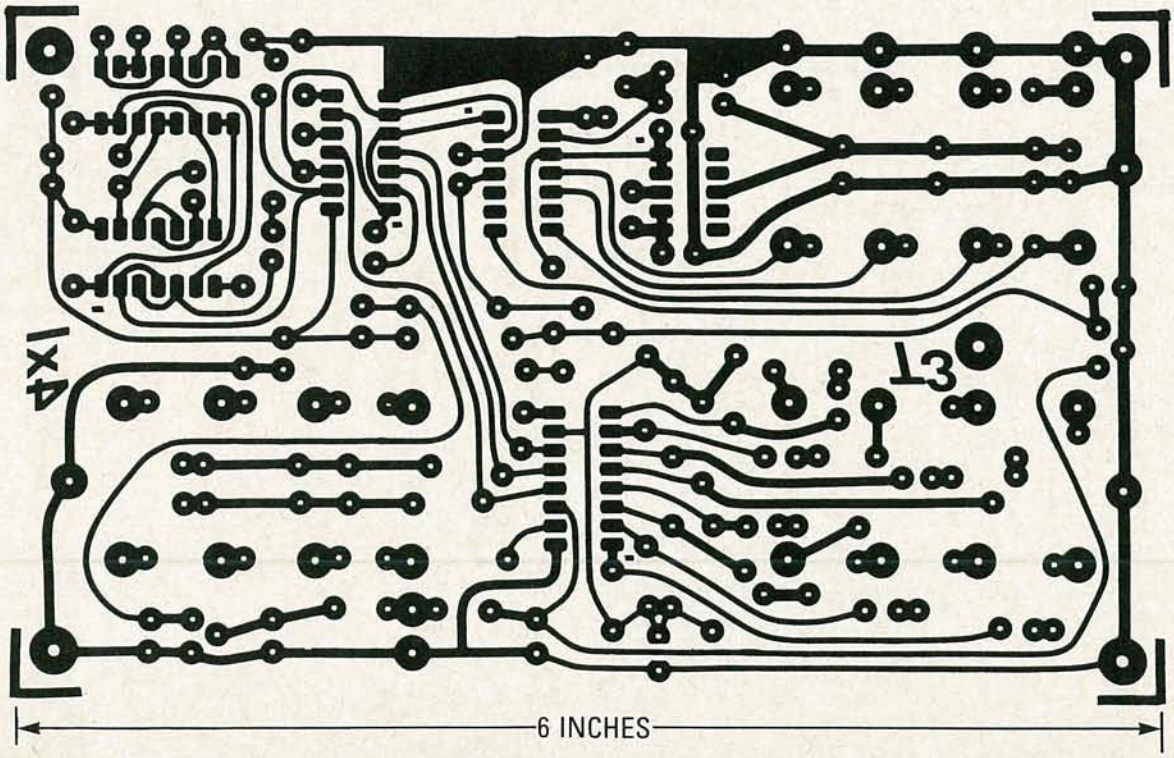
In order to produce a board directly from the magazine page, remove the page and carefully inspect it under a strong light and/or on a light table. Look for breaks in the traces, bridges between traces, and in general, all the kinds of things you look for in the final etched board. You can clean up the published artwork the same way you clean up you own artwork. Drafting tape and graphic aids can fix incomplete traces and doughnuts, and you can use a hobby knife to get rid of bridges and dirt.

An optional step, once you're satisfied that the artwork is clean, is to take a little bit of mineral oil and carefully wipe it across the back of the artwork. That helps make the paper transluscent. Don't get any on the front side of the paper (the side with the pattern) because you'll contaminate the sensitized surface of the copper blank. After the oil has "dried" a bit—patting with a paper towel will help speed up the process—place the pattern front side down on the sensitized copper blank, and make the exposure. You'll probably have to use a longer exposure time than you are used to.

We can't tell you exactly how long an exposure time you will need as it depends on many factors but, as a starting point, figure that there's a 50 percent increase in exposure time over lithographic film. But you'll have to experiment to find the best method for you. And once you find it, stick with it.

Finally, we would like to hear how you make out using our method. Write and tell us of your successes, and failures, and what techniques work best for you. Address your letters to:

**Radio-Electronics**
Department PCB
500-B Bi-County Blvd.
Farmingdale, NY 11735




**BUILD THE AUIDO/VIDEO switcher usng this PC board.**

# PC SERVICE

# HARDWARE HACKER

## Superconductors for the hacker, and more!

**More on uv curing resins**
**Using liquid level detectors**
**Circuits for electronic music**
**Microprocessor fundamentals**
**Off-the-shelf superconductors!**

DON LANCASTER

HELLO AGAIN. WELCOME TO RELEASE number two of my brand new **Radio-Electronics** column. As we found out last month, we will be exploring all sorts of "neat stuff" hacker opportunities here, electronic and otherwise. We will start off with a reminder that you can get no-charge technical help at the number in the *Need Help?* box that accompanies this article.

I've found out a little more on suitable UV curing resins for that Santa-Claus machine that we looked at in the last installment of this column. It turns out that a leading manufacturer of photopolymerization resins is Hercules.

One fairly cheap and easy to get UV curing resin of theirs is used for making rubber stamps. That UV liquid resin is rebranded by the Merigraph Systems people as their product *MD-035*, and is distributed by R.A. Stewart.

The really big news this month is that hardware hackers can now buy superconductors off-the-shelf to play with!

### Superconductors for the hacker

When you cool certain metals or "magic" ceramic-oxide mixtures to extremely low temperatures, a very remarkable thing happens. Some of those materials will go into a *superconducting* state where they lose all of their internal electrical resistance. At the same time, any internal magnetic fields also will drop to zero.

The many potential uses for superconductors boggle the mind. Utility electrical power could be distributed long distances without transmission loss. Much stronger and cheaper magnets for electric automobiles, transportation, atomic-particle research, and biomedicine would revolutionize each of those fields. Computers could be made much faster and much smaller. So, too, could new test instruments.

Until recently, the temperatures needed for superconductivity were so cold that only very expensive and cumbersome liquid helium could be used. But, within the last year, a new class of ceramic oxides consisting of copper, oxygen, and some rare-earth elements were discovered that superconducted at much higher, more economical temperatures.

Those new ceramic materials will superconduct in the 80°K to 100°K range (−173°C to −193°C). Now, that is still extremely cold, but you can easily hit those temperatures with cheap old liquid nitrogen in a styrofoam cup. Liquid nitrogen is available at less than draft-beer prices from almost any industrial gas supply house.

Better yet, there are hints of superconductivity at much higher temperatures, some of which even approach room temperature. But those new developments are not yet confirmed or proven, and the whole field is up for grabs.

In fact, the entire future of electronics hinges on all of the new superconductor research being done worldwide today.

Believe it or not, you can run out right now and buy your own superconductor to play with for only $8. One source of them is Laboratory Specialists.

What you get is not all that great looking. Your superconductor is the size, color, and shape of a pool cue tip. It is also very sensitive to moisture or to any oxygen when at low temperatures, so it can easily be degraded or destroyed. About all you can really do with it is demonstrate the fundamental superconductor properties—a zero internal-magnetic field and a zero resistance. On the other hand, it is a guaranteed instant winner for a school paper or a science fair.

Before we go on, though, let's talk some safety. You should treat liquid nitrogen like it was molten steel. It will instantly frostbite any tissue it comes in contact with. Safety glasses are an absolute must. You should also wear two layers of heavy clothes that cover as much of your body as possible. Be sure to review your frostbite first aid before beginning.

You must work in a very well ventilated area. While the liquid nitrogen is not itself toxic, it will displace oxygen in any confined area and can cause suffocation. Just confining the liquid nitrogen can cause a pressure explosion, so a loose fitting lid must be used on any non-approved container.

Some materials will instantly

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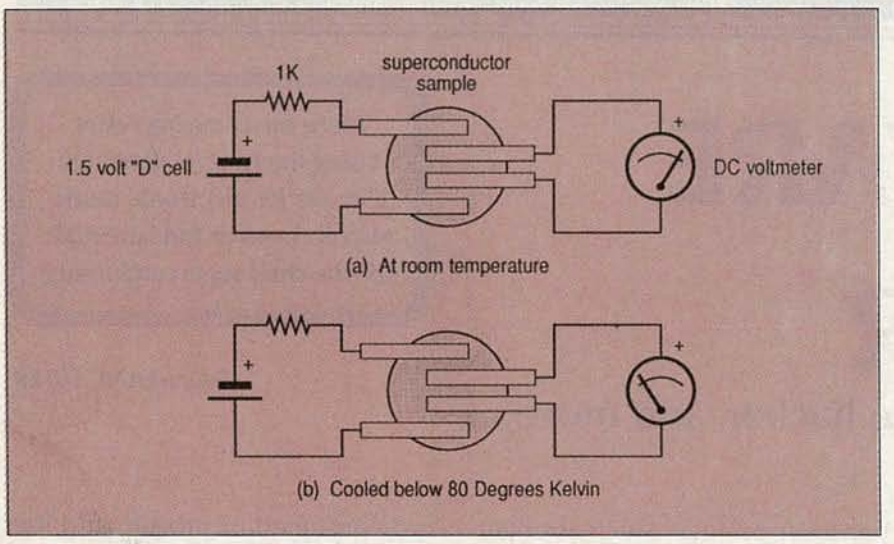


**FIG. 1—A TEST CIRCUIT to demonstrate the zero internal resistance of a cooled superconductor. The meter will show a zero voltage drop when the super conductor is below its critical temperature. A "four-point" measuring scheme is used to minimize the effects of contact and lead resistance.**

shatter at liquid nitrogen temperatures, so the safest container is a plain old styrofoam coffee cup. Meanwhile, any liquid oxygen that condenses out can become a very serious fire hazard.

Are you still there? Hello....Hello...

Actually, when treated with both common sense and respect, the dangers of liquid-nitrogen handling are no worse than, say, using a power lawnmower.

Figure 1 shows us how to demonstrate superconductive properties. Basically, you set up the superconductor as a voltage divider and measure the output voltage. As you slowly lower the material into the liquid nitrogen, the output voltage will drop to zero, proving that the material is superconducting.

Figure 2 shows you how to demonstrate a second measure of superconductivity. That is called the *Meissner effect*. The Meissner effect says you will get a zero internal magnetic field when the material you are working with is actually superconducting.

That effect does take a special, extra strength neodymium-iron-boron magnet. Physically levitating the magnet is not usually possible with these samples.

For more information, and for more cautions, be sure to thoroughly read the instructions that come with your sample of superconductor material.

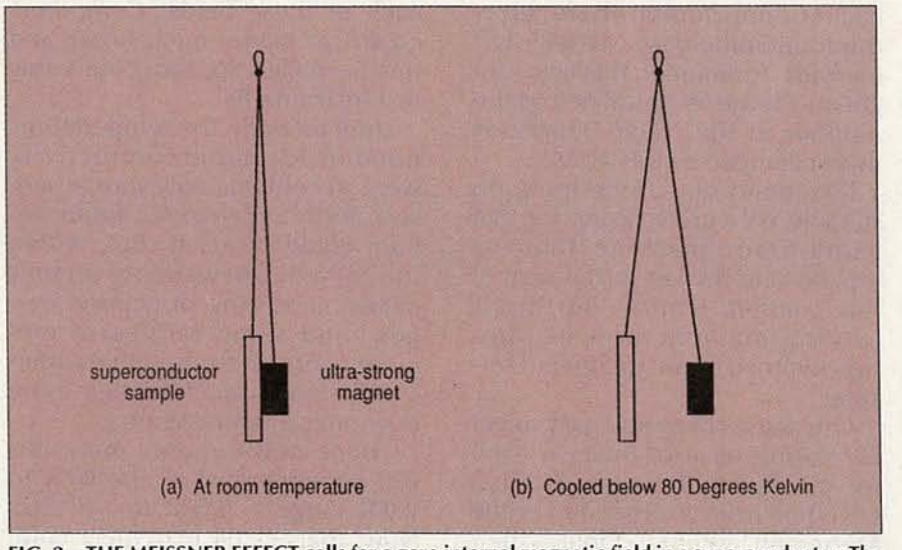


**FIG. 2—THE MEISSNER EFFECT calls for a zero internal magnetic field in a superconductor. The resulting field distortion will deflect, or even levitate, an extremely strong magnet as shown.**

## Making your own

Doing all your own personal superconductor research is rather tricky for the average hardware hacker, but it is certainly not out of the question. The basic technology is just about as complicated for you as microwaving a pan of brownies.

And a Nobel Prize is up for grabs for the first confirmed and verifiable stable room-temperature superconductor. Not to mention a very big bag of nickels.

Dimes, even.

First and foremost, you would have to be a lab-type person, and have access to either a school chemistry lab or else have your own very sophisticated home lab.

Second, of course, would be a very healthy respect for the dangers of working with those very low temperatures. Once again, safety glasses, heavy, double-layered clothing, good ventilation, and everyday common sense are always essential.

Third, you would need reprints of many of the current papers in superconductivity. While there are some expensive new journals out, check into Physics Abstracts, Science, or, best of all, the Dialog online technical and scientific information utility. All of those should be readily available at better schools and libraries.

Two rather good technical resources to get you started are the special superconductor issue of *Physics Today* (volume 39, #3, 1986) and Bednorz and Muller's classic paper in *Science* (volume 237, pages 1133-1139).

And, finally, you would need a source of raw materials. The AESAR people have long been a good source of small quantities of high purity metals, compounds, and elements. They have released a new superconductor-materials flyer that includes barium, strontium, scandium, copper, lanthanum, and yttrium in just the right combinations for the new superconductors. Cost ranges from $1 to $87 a gram in small quantities, depending on the material.

Be sure to let us know what results you come up with in this exciting new field.

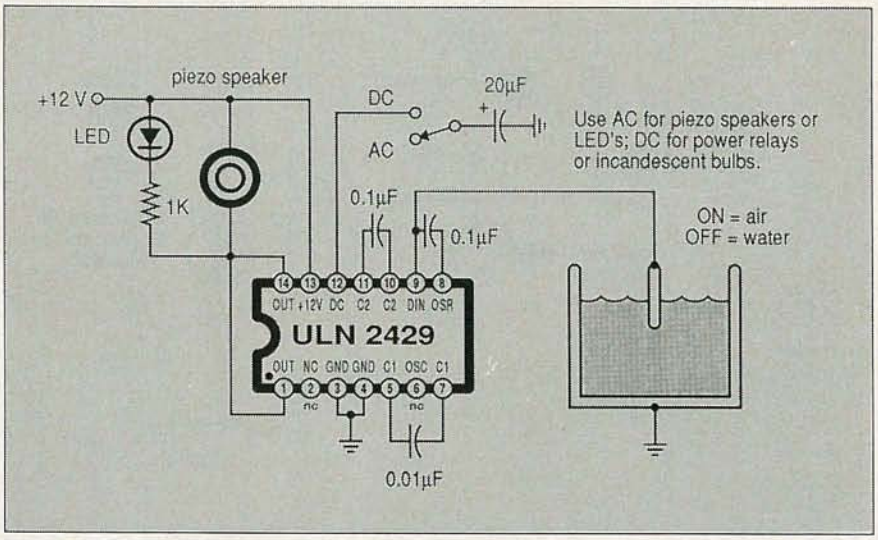


**FIG. 3—THE SPRAGUE ULN-2429 is an automotive liquid-level detector that has plenty of hacker potential. Here is the basic test circuit using a pop can full of tap water.**

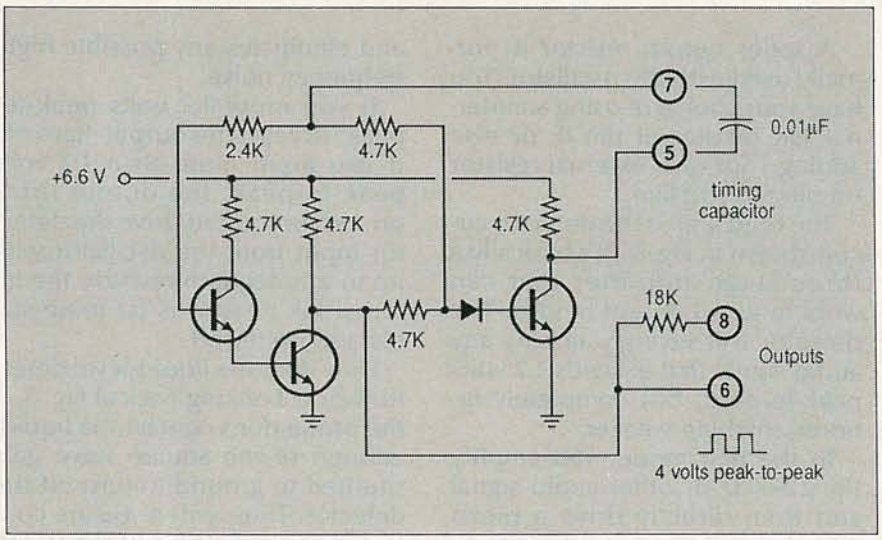


**FIG. 4—A SIMPLIFIED SCHEMATIC of the internal audio oscillator found in the ULN-2429. The usual operating frequency is 2.5 kHz, and is set by the external timing capacitor.**

## Liquid-level detectors

THE AUTOMOTIVE PEOPLE HAVE SHOWN a lot of interest lately in liquid-level detectors, particularly for low-radiator-water warning systems. There are quite a few circuit manufacturers that offer specialized IC's for liquid-level detection.

One interesting and low cost liquid-level detector is the Sprague ULN-2429A. That beastie is shown in Fig. 3.

There are three basic areas to the circuit. Those areas of the circuit include a regulator, an oscillator, and a detector.

The first circuit area is a 6.4-volt regulator that isolates the rest of the internal electronics from any battery and vehicle noise. Because of that regulator, the intended supply is from 10 to 16 volts.

For hacker uses, you can run on a 9-volt battery, but with less stability and accuracy than when running at the intended 12 volts. The current drain is under 10 mA, exclusive of the load.

The second area consists of a simple audio oscillator. You can change the frequency of that oscillator by changing the timing capacitor between pins 5 and 7. The intended operating frequency is 2.5 kHz, which can be used to directly drive a ceramic piezo squawker device.

A simplified circuit of the audio oscillator is shown in Fig. 4. It is a fairly low-power circuit, intended to work into a 10K or higher load. The output is a rather sloppy square wave of about four volts peak-to-peak.


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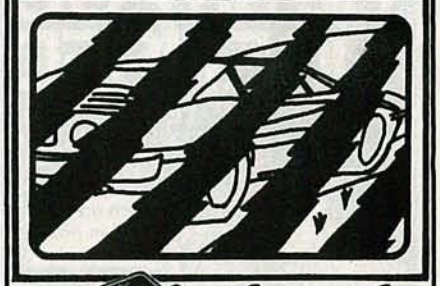

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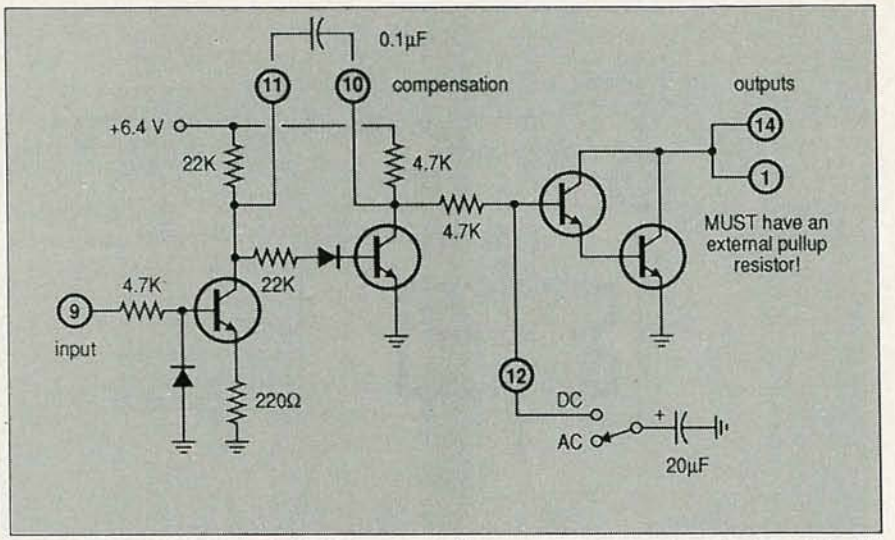


**FIG. 5—THE ULN-2429 DETECTOR turns on with a square-wave input greater than 1.2 volts peak-to-peak, and stays off otherwise. The filter capacitor selects either an AC or DC output.**

A series output resistor is normally used with the oscillator. You have your choice of using an internal 18K resistor at pin 8, or else adding your own external resistor on pin 6 if you like.

The third area is the detector circuit shown in Fig. 5. It's basically a three-stage amplifier that can work in two different modes. The detector will strongly amplify any audio signal that exceeds 1.2 volts peak-to-peak, but completely ignores anything weaker.

In the first mode, you amplify the 2.5-kHz or other audio signal and then directly drive a piezo transducer at the output. You can also drive an LED with that square wave if necessary.

There is one gotcha to driving an LED. You have to use a series resistor to make the peak LED current *twice* normal, since the output square wave will only be on *half* the time.

Should you close the AC-DC switch in Fig. 3, the output stage becomes a high-power DC driver that is capable of driving a relay or an incandescent lamp. You can output as much as one ampere from that tough driver circuit, if you use a heatsink clip and are certain to connect both output pins 1 and 14 to a large printed circuit foil area, as well as connecting both of ground pins 3 and 4 to a similar large foil area.

The capacitor on pins 10 and 11 reduces the frequency response of the detector to what is needed, and eliminates any possible high-frequency noise.

If you input 1.2 volts peak-to-peak, or less, the output stays off. If you input more than 1.2 volts peak-to-peak, the output turns on. While you can drive the detector input from the oscillator with up to a 1-megohm resistor, the internal 18K resistor is far more stable and preferred.

How does the liquid-level detector work? Looking back at Fig. 3, if the probe does contact the liquid, enough of the square wave gets shunted to ground to turn off the detector. Thus, when you are contacting liquid; the output is off. When your coolant drops below the probe, the output turns on.

The Sprague data sheet also shows a series double-probe setup that turns the output on only when in contact with the liquid. But note that the alternate circuit will only work with isolated liquids that are not grounded. A liquid without a conductive or capacitive path to ground is highly unlikely in the real world.

Suitable liquids are tap water, sea water, weak acids and bases, wet soil, wine, beer, or coffee. Most oils, distilled water, dry soil, or vodka will not work.

One of the reasons for using an audio signal rather than a DC voltage for a level sensor is to prevent any plating or electrolysis effects that might alter the sensor probe over time.

When you are working with tap

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water, there are three different forces at play. If you just shove an ohmmeter into a pop can full of tap water, you most likely will measure something in the 5- to 20-megohm range. That, obviously, is far too high to be able to shunt the 18K resistor.

But water has a dielectric constant of 84. Thus, what might have been a 10-pF capacitor when the probe is in air becomes an 840-pF capacitor when wet.

Finally, most any material has its loss tangent, which tends to attenuate high frequencies more than low ones. Therefore, any ions floating around in the tap water will further lower the impedance.

That sure had me fooled for a while. Intuitively, you would expect probed tap water in a pop can to look like something much higher than an 18K resistor at audio frequencies. But the triple combo of conduction, an exceptionally high dielectric constant, and an increasing loss tangent all gang up to let the simple circuit work like a real champ.

Just because the IC is called a level detector does not mean that us sneaky hackers can't do wildly different things with it. For example, you can think of the device as a simple audio oscillator and a thresholding level detector with either AC or high-current DC outputs. Between the oscillator and detector, we have the options of making or breaking a series connection, or of shunting or not shunting some of the oscillator signal to ground.

So, for this month's contest, just dream up a new use for the ULN-2429A. Paper ideas are just fine; you do not have to actually test your circuit. There will be one of my books to the best twenty entries, and an all-expense-paid (FOB Thatcher, AZ) *tinaja* quest to the best of all.

I will eliminate the two most obvious new uses by showing them here as examples: You can make a


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continuity tester by using the oscillator and detector leads to do such things as ringing out cables. By replacing the water sensor with a long wire, you can create a burglar alarm that trips whenever the wire is cut.

Let's see what else new and exciting you can come up with using those new devices.

### Music IC's

As with anything electronic, there are two different types of high-performance electronic-music circuits: digital and analog.

The digital ones are used for such things as polyphonic and polytonic oscillators and envelope generators. One major source of those is Ensonig, whose IC's are used in many popular high-end synthesizers. Their 5503 synthesizer IC is used in the Apple *IIgs*, and gives the *IIgs* far and away the finest sound available from any personal computer.

The analog IC's for electronic music are more traditional and include such things as voltage-controlled oscillators, amplifiers, and filters. The Solid State Micro Technology (formally SSM, or Solid State Music) people seem to be the leader in this area. They have a free *Product Guide* you may want to send for.

### New tech lit

Those new data books are continuing to pour in. Check out the *CMOS Data Manual* from Signetics, the new *CMOS/NMOS Special Functions* data book available from Motorola, a really great *Pressure Sensor Handbook* from SenSym, and the new *Modem Design Booklet* from Exar.

As with most data books, the price varies from free to optional to nominal, depending both on your supplier and how you go about asking for one.

For a most useful new hacker structural material, try *Gatorfoam* from International Paper. That flat, rigid, strong, and lightweight stuff is available in thickness from 3/16 to 1½ inches and is much easier to handle and use than most of the woods, wood substitutes, and plastics. It is absolutely ideal both

*continued on page 96*


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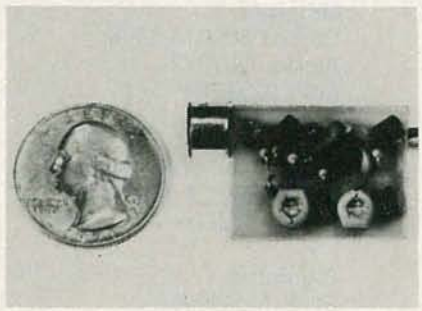

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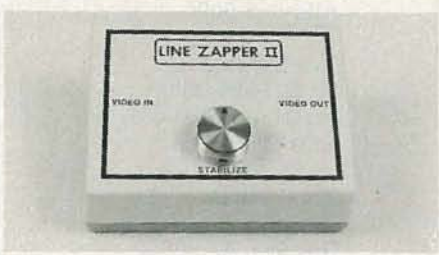


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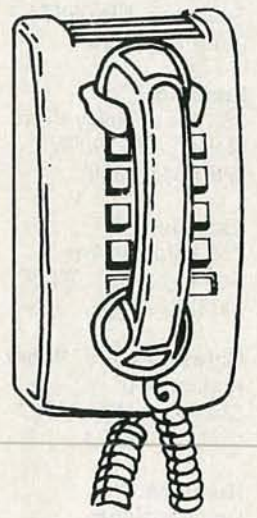

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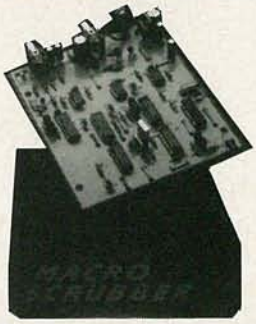

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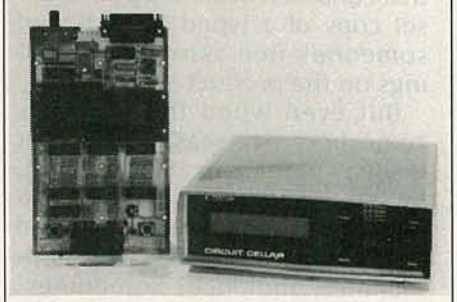

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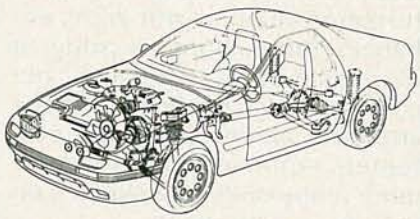

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# AUDIO UPDATE

**LARRY KLEIN,**
AUDIO EDITOR

## Documentation difficulties

THE OTHER DAY I HEARD A STEREO-equipment dealer tell a customer that if he found the "documentation" for some of his just-bought audio components unclear, he, the dealer, stood ready to answer any questions that might arise. For me, that raises two matters worth discussing: When did audio instruction manuals become "documents?" And, more important, why did the dealer *expect* the documents/manuals to be unclear? The use of the term "documentation" is, of course, simply another minor example of the kind of jargon that puts roadblocks in the path of communication. Lord knows, stereo technology is difficult enough to explain without injecting computerese.

Because the technology is both difficult to understand and rapidly evolving, one might imagine that manufacturers would make special efforts to provide clearly written, well-illustrated instruction manuals. A clear, attractive, and interesting manual not only enhances the customer's pride of ownership in his equipment, but could do much to eliminate those after-sale phone calls from customers confused about one or more of the operating features on their new components.

### The source of the problem

Of course, there are some manufacturers whose instructions are all that any one could ask. But why are so many manuals so incomplete, so strangely worded, and, in general, so inadequate? Almost all of the problem occurs because most of audio equipment sold in the U.S. is not only made, but also written about in the Orient. (I say *almost* all, because for more than a year one U.S. manufacturer of a very sophisticated and complex preamplifier provided an "instruction manual" that consisted of a thick photo-offset copy of a typed transcript of someone's free-association musings on the product.)

But even when the products come from overseas, aren't their manuals written, or at least edited, by someone with at least some talent for communicating technical instructions in English to a nontechnical audience? Sometimes, but certainly not always. I suspect that many U.S. importers are so pleased to get *any* printed material along with the product that they are not about to complain about such "trivial" matters as clarity, accuracy, or prose style! The following are two true, illustrative, personal anecdotes:

**Case 1.** I once received a frantic call from an audio sales manager surrounded by samples of his new line. They had arrived the day before completely devoid of any descriptive literature. His problem was that he needed to get some fast printed material out to his sales representatives, but he wasn't sure that he fully understood the features and characteristics of the products that the Japanese had chosen to ship to him. My job, if I cared to accept it, was to go over each product and dictate into a recorder as much as I could deduce about its specifications, features, and functions.

Obviously, that was a worst-case situation, but it's not at all uncommon for a U.S. subsidiary or importer (or advertising agency) to be presented with a line of new products said to have "special design features" that, at best, are far from self-explanatory, and, at worse, make no sense at all. Which brings us to:

**Case 2.** I was asked by the U.S. sales manager of a respected high-end Japanese audio line to produce a technical "white paper" explaining a new "revolutionary" (aren't they all?) amplifier circuit used in this year's products. After studying the schematics and the quasi-English technical gobbledygook that purported to describe the new circuit—let's call it Gamma-Plus—and its purpose, I generated about 1,500 words of what I hoped were plausible explanation and justification. I ran them by the company's U.S. technical consultant who admitted to being no wiser than I about the absolute technical truth of the matter, but who thought my guesses about the operation and purpose of Gamma-Plus were as good as any he had yet heard.

I submitted my white paper, it was accepted and subsequently became part of the press kit to be given out at the press conference—which I was scheduled to attend—where the Japanese president and chief engineer would introduce the new Gamma-Plus line. During the question and answer part of the conference I tried to get an authoritative explanation of Gamma-Plus from the company's chief engineer. In reply to my questions, he assured me that there was an "excellent explanation in the press kit"—thus

*continued on page 97*

VOL. 5 NO. 2 FEB. 1988

# COMPUTER DIGEST

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### A package for every pocketbook

## BUILD THE PT-68K

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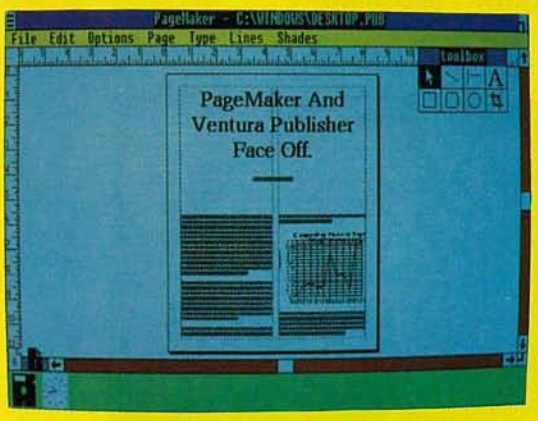


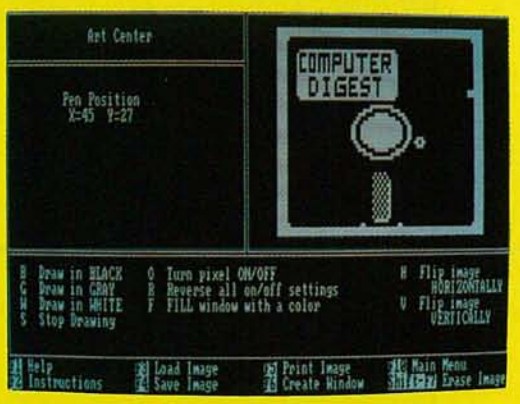

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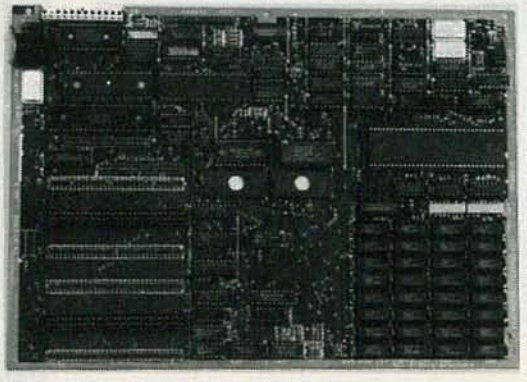
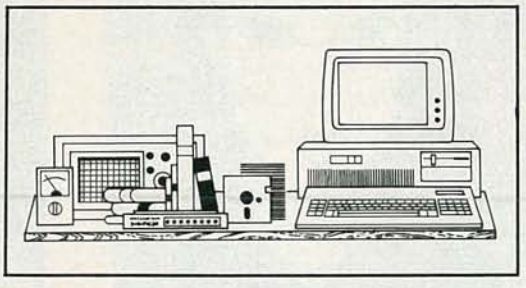


**91 CD CLASSROOM, PART 5**
Expanding the PT-68K



**83 EDITOR'S WORKBENCH**
A no-slot clock for IBM and Apple II
ZBASIC for MS-DOS, Z80, Apple II, and Macintosh

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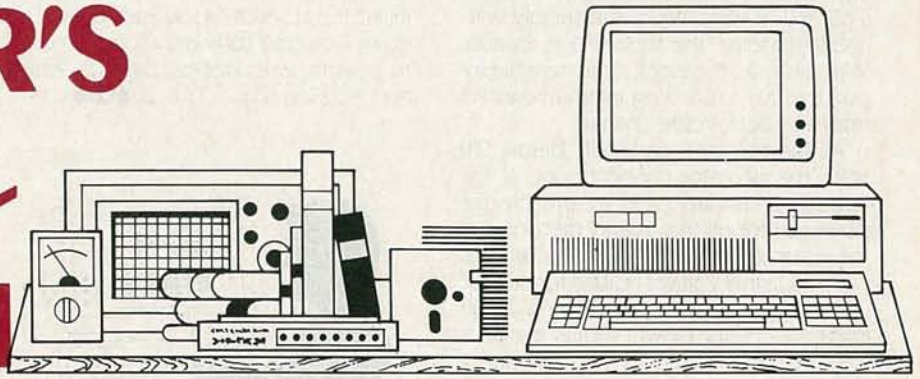
# EDITOR'S WORK-BENCH



## No-Slot Clock for IBM and Apple II

Few things are more annoying than having to enter the time and date every time you boot your PC, XT, or clone. But if you don't enter the correct time and date, you lose a valuable source of information about when your files are modified and created. In addition, you lose flexibility in backing up your work if your files aren't correctly dated.

IBM corrected the deficiency in the AT, which includes its own battery-backed clock. PC and XT owners can correct the deficiency by adding an external clock, and there are several ways of doing so. A simple and inexpensive single-function—clock only—expansion card may be inserted in any available slot, as may a multi-function card. The problem is that you must give up a slot in either case, and because most clone motherboards now have 640K of built-in memory, the multi-function card's memory must go unused.

Systems Manufacturing Technology, Inc. has developed a simple, elegant, and low-cost solution to the problem; it's called the No-Slot Clock, and it's available from the distributors mentioned in the sidebar.

### What it is

The No-Slot Clock is a single-chip real-time clock/calendar that quickly and easily mounts in a PC, XT, PCjr, or clone to provide AT-like clock features. No expansion slot is required; normally you would install the clock in a ROM socket—used or unused.

The clock provides the following information: hundredths of a second, seconds, minutes, and hours, and it is accurate to within two minutes a year. In addition, date, day of week, month, and year are provided by the IC. Adjustments for leap years and months with fewer than 31 days are performed automatically.

The clock's design is unique in that batteries are contained within the IC itself. Using techniques pioneered by Mostek in early 1983, the No-Slot Clock has two long-life lithium cells embedded in its sealed, 14-pin plastic DIP case. The batteries serve as backup power when the main power supply fails or when the machine is turned off. The batteries have a life expectancy of 10 to 20 years, and never need replacing. In fact, Systems Manufacturing Technology unconditionally guarantees the No-Slot Clock—including batteries—for a full 10 years!

The clock contains a circuit that

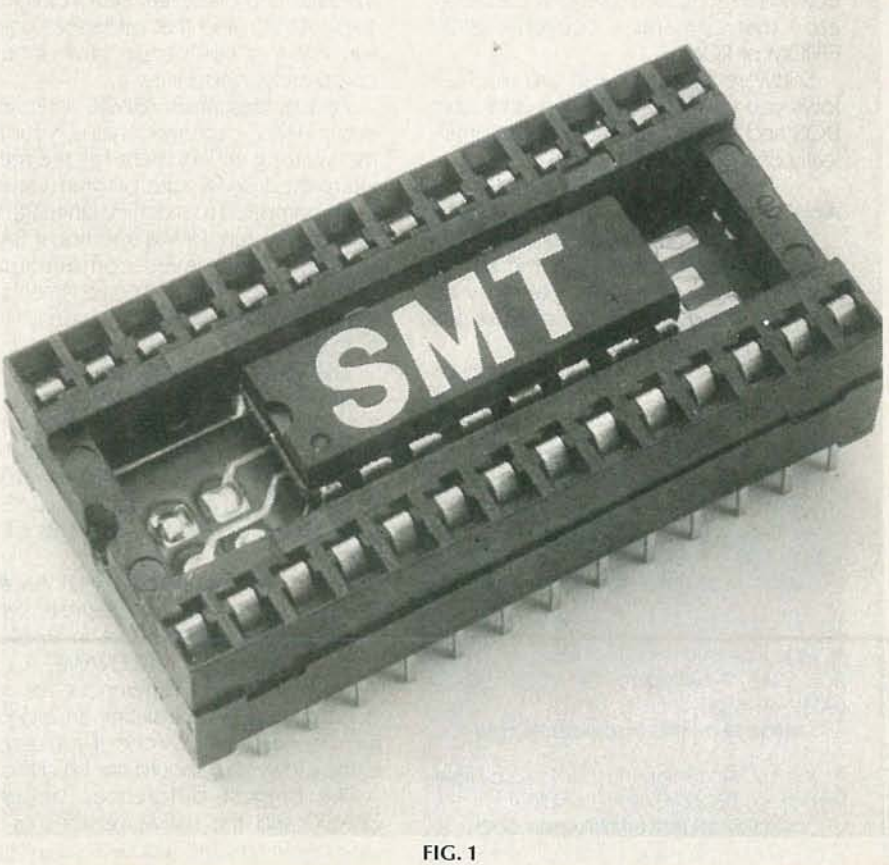



FIG. 1

monitors the state of the batteries, as well as the power-supply voltage. The circuit trips when the power supply drops to 4.63 ±0.12 volts. When the supply voltage falls below the trip voltage, control logic disables the clock's chip-enable input, thereby protecting internal registers from accidental data change.

As the power supply falls below 3.0 volts, the detector connects one of the three-volt lithium cells to the clock's power distribution bus and disconnects the external supply. The independent cell with the higher voltage is used for power.

During power-up, the switching circuit triggers when the power supply exceeds 3.0 volts, disconnects the lithium battery from the circuit, and reconnects the main power supply. As voltage passes the 4.63 volt threshold, the chip-enable input itself is enabled, thereby allowing the chip to become fully operational.

### Installation

The clock IC itself is a 14-pin DIP that is mounted inside a 28-pin DIP extender socket, as shown in Fig. 1. To install it in an IBM type machine, locate an empty 28-pin ROM socket on your motherboard, and plug in the assembly. If you have no empty socket, simply remove a socketed ROM IC, insert the No-Slot Clock in the socket, and then replace your ROM. True-blue PC's and some clones use 24-pin ROM's rather than the newer 28-pin ROM's. In that case, just install the No-Slot Clock on an adapter board (a CGA or EGA video adapter, a hard-disk controller, etc.) that contains a socketed BIOS EPROM or ROM.

Software supplied with the clock allows you to set the time and date from DOS and to recall the settings automatically on power up.

### Apple version

The No-Slot Clock can also be used in an Apple IIe. Even though the Apple doesn't require time and date entry on power up, many programs make use of a clock if it is available.

The No-Slot Clock is easily installed on the IIe motherboard in the 28-pin ROM socket labeled CD. Simply remove the ROM IC that is mounted in that socket, insert the No-Slot Clock, and replace the ROM. Included software allows the clock to operate with ProDos, Dos 3.3, Pascal, and Appleworks.—*TJ Byers*

The No-Slot Clock is manufactured by Systems Manufacturing Technology, Inc. (1145 Linda Vista Drive San Marcos, CA 92069, (800) 648-6262, (619) 744-3590).

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The No-Slot Clock is distributed by:

- Jade Computer, 4901 W. Resecrans Ave., Box 5046, Hawthorne, CA 90251-5046, (800) 421-5500

**CIRCLE 19 ON FREE INFORMATION CARD**

- and by Micromint, Inc., 25 Terrace Drive Vernon, CT 06066 (302) 871-6170.

**CIRCLE 20 ON FREE INFORMATION CARD**

## ZBASIC, for MS-DOS, Z80, Apple II, and Macintosh

Basic is the language of choice for millions of people, ranging from rank beginners to dyed-in-the-wool hackers. In the past few years, the large system-language houses (Microsoft and Borland) have been battling by introducing new versions of the language that are light years beyond what was available only three or four years ago. Meanwhile, a small company named Zedcor has quietly been building a version of BASIC that has many of the features of Quick and Turbo BASIC, and that addresses one issue the big companies have ignored completely: portability.

Zedcor describes ZBASIC as an interactive BASIC compiler. That is, your normal working environment has the feel of interpreted BASIC, but programs are actually compiled to machine language before they're run. Unlike traditional BASIC compilers, however, compilation is fast—so fast, in fact, that for small programs you'll hardly notice compilation time at all.

ZBASIC is generally compatible with other versions of BASIC available for the target machine, but there are differences that prevent strict one-for-one translation. For example, in the MS-DOS version, ZBASIC will not accept standard BASICA (GW-BASIC) open file statements of the form:

```
OPEN "FILENAME" FOR INPUT AS #1
```

Rather, you must use the alternate syntax (which is also acceptable in BASICA):

```
OPEN "I", #1 "FILENAME"
```

All such syntactic differences are well documented, so translating an old program or writing a new one, if you're used to the old syntax, should not be difficult.

The biggest differences between ZBASIC and the native versions of the language are in the graphics statements, which have been standardized among all versions (MS-DOS, Z80 (including CP/M and TRS-80), Apple, and Macintosh) of the compiler. Graphics programs are written to conform to a device-independent coordinate system, so, theoretically, the source code of a graphics program written for one computer should compile and run on another.

```
00010 A$ = TIME$
00020 FOR I = 1 TO 500
00030 PRINT STRING$(62,"*")
00040 NEXT
00050 B$ = TIME$
00060 PRINT "Start time: ";A$
00070 PRINT " Stop time: ";B$
00080 END
```

There are numerous small goodies that BASIC aficionados will enjoy. In the MS-DOS version, for example, in addition to the standard CGA graphics of BASICA, both EGA and Hercules graphics are supported; arrays are not limited to 64K; a full-screen editor is instantly available; serial communications buffers can be maintained automatically; mice are supported; line numbers are not necessary; subroutines can be called by name; multi-line functions are supported; CASE, DO UNTIL, and multi-line IF statements are supported; the LIST command can highlight keywords; UNNUM removes unnecessary line numbers; and many more.

On the other hand, some statements have been left out inexplicably. For example, the INPUT$ function (which is part of most Microsoft versions of BASIC is absent and is sorely missed.

### Using ZBASIC

After typing your program in, you can run it or compile it to produce a stand-alone executable (COM) file. The .COM file always contains the entire support library, so the following program compiles to a file that is about 20K in length:

```
00010 PRINT "HELLO"
```

However, ZBASIC programs run fast. For example, the program shown in Listing 1 runs in about 25 seconds in either the ZBASIC environment or as a stand-alone COM file; BASICA runs the program in about 92 seconds!

Zedcor includes a thick manual of more than 700 pages. Approximately half includes material that is applicable to all versions of the compiler; the rest are appendices with information specific to each implementation.

ZBASIC is available from Zedcor, Inc., 4500 East Speedway Blvd., Suite 22, Tucson, AZ 85712-5305, 800-482-4567, 602-795-3993. The current price of the IBM, Macintosh, and Z80 versions is $89.95; the Apple DOS 3.3 and ProDOS versions cost $49.95.

# DESKTOP PUBLISHING

*What is desktop publishing? What hardware and software are required? Must it be expensive? Read on . . .*

**JEFF HOLTZMAN** TECHNICAL EDITOR

Desktop Publishing—everybody's talking about it, but nobody knows exactly what it is. To some people, a specific program defines the field: If a program can do what program X does, it does desktop publishing. But many programs claim to do desktop publishing, and can't really, whereas many other programs don't claim to, and actually can.

In an attempt to remedy the confusion, here's a simple definition: A program does desktop publishing if it can merge bit-mapped graphics with text, and if it can produce that text in a variety of fonts (specific sizes of specific typefaces).

That definition allows us to view desktop publishing not as a *this* or a *that*, but as an activity with a range of possibilities. A skateboard and a Mercedes Benz both provide transportation, but obviously, each has different capabilities that appeal to different users. Thus, a $50 program running on a $500 PC clone and printing on a $200 printer differs in degree, not in kind, from a $7000 program running on a $10,000 80386-based machine and printing on a $20,000 laser printer.

With that in mind, in this and the accompanying article, we'll examine half a dozen programs, each of which occupies a separate niche in the desktop-publishing spectrum. The programs we'll discuss (PageMaker, Ventura Publisher, PFS: First Publisher, Inset, The Printing Press, and Lotus Manuscript) represent a non-comprehensive sample of what's available, but several products are unique (Manuscript and Inset).

As for hardware, Printing Press and Inset will run a floppy-only system; the others require a hard disk. All programs will run on a standard IBM PC, XT, or compatible; but unless you've got a great deal of patience, you'll want an AT-class machine (or a PC with an accelerator card). All but Manuscript and Printing Press work with an optional mouse. In fact, menu and graphic manipulation is much easier with one, but keyboard-only operation is also possible.

## Overview

PageMaker, Ventura, and PFS all function in a graphic environment, wherein menus for accomplishing various actions drop down from the top of the screen. All menus and other text are presented in bit-mapped graphics form, so speed is required for all but the most occasional (and patient!) use.

PageMaker runs under Microsoft Windows, Ventura runs under Digital Research's GEM (Graphics Environment Manager), and PFS runs in its own proprietary environment. Windows and GEM are similar in that they provide both a consistent user interface that simplifies using a broad range of programs, and a consistent programmer interface that simplifies (in some senses) writing those programs. See the accompanying article for more information on PageMaker and Ventura Publisher.

Inset is a ram-resident program that monitors keyboard input and printer output. When Inset's hot key is pressed, the program pops up and allows you to integrate graphics images (created from scratch in Inset, or captured from other programs) with text. You use your word processor's normal print function to print a document that contains such an image; Inset automatically merges the graphics image with your text.

The Printing Press is an inexpensive program that allows you to create signs, greeting cards, etc., quickly and easily.

Lotus Manuscript provides a complete environment for creating documents, from initial note-taking to final printing. It combines a word processor, an outliner, and a flexible page-printing system. Of course it accepts Lotus 1-2-3 graphs, other types of graphics images, and it allows you to create tables and formulas easily.

## PFS: First Publisher

From the makers of several entry-level products (word processors, database managers, etc.) comes PFS: First Publisher, an amazing and frustrating $99 package. It's amazing in what it can do (considering the price), and frustrating in how it does—or doesn't—do what it's supposed to do.

First Publisher has a complete graphics interface with drop-down menus. A mouse is not required, but makes most operations much easier. First publisher can drive just about any PC graphics adapter (CGA, EGA, and Hercules), and many printers, both dot-matrix and laser (HP and Apple) as well.

You work with the program in two layers: graphics and text. The placement of text is determined by *baselines,* analogous to ruled lines on paper. Baseline length and position is adjustable singly and in groups (by column, and above or below a given baseline.) Figure 1 shows the baseline display for our sample.

After setting the baselines, allowing space for graphic images, you can flow the text. (See Fig. 2.) The text must be formatted with CR's (no LF's). PFS word processors apparently do so, but few other word processors do, so you may need a conversion utility to get your text into First Publisher. You can also type text directly into the program, but only limited editing is available. First Publisher does no hyphenation, so when you flow text into your publication, you'll either have to hyphenate it manually or live with large gaps between words on some lines. By contrast, both PageMaker and Ventura are able to hyphenate words automatically.

Then you switch to the graphics layer. Graphics handling is First Publisher's strong point; the program provides a miniature graphics editor (which neither PageMaker nor Ventura Publisher provide), in addition to the usual tools for creating ruled lines and boxes. Also, First Publisher comes with five "sheets" of clip art with various images that you may "clip" and edit using the graphics editor. The latter includes tools for flipping a selected image horizontally and vertically, resizing it, pixel-level editing, "inverting" (changing all black to white, and vice versa), and more.

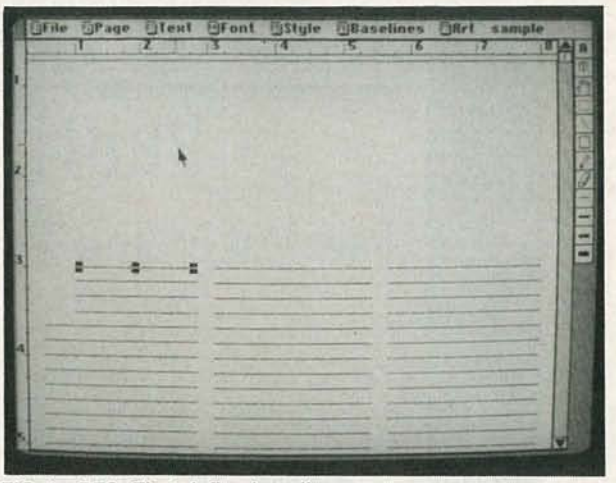


**FIG. 1—PFS: First define baselines.**

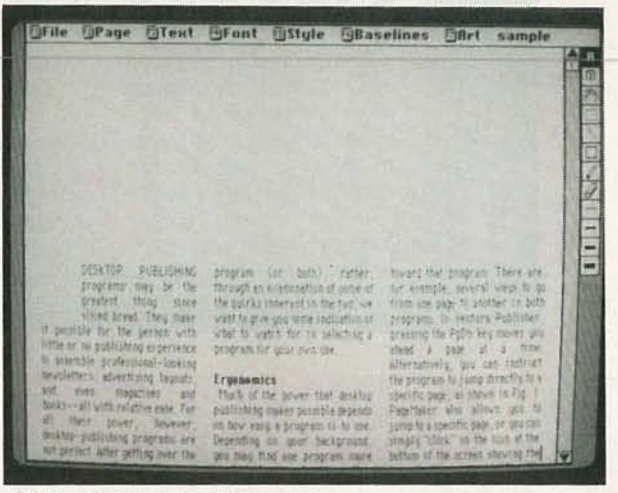


**FIG. 2—PFS: Next add your text.**

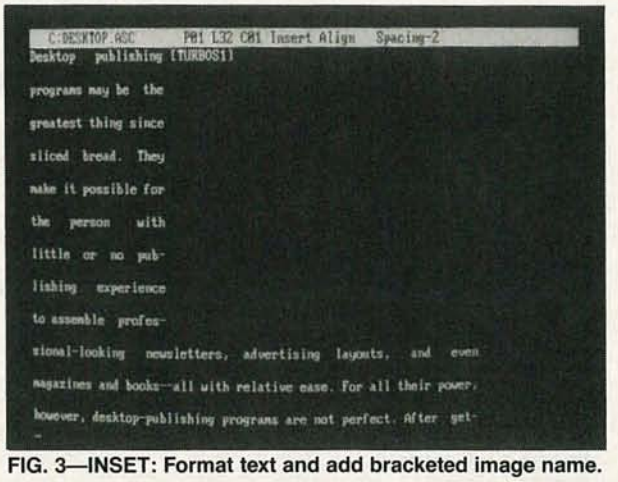


**FIG. 3—INSET: Format text and add bracketed image name.**

You can also enter text (in any of the approximately 60 fonts provided) on the graphics layer; after pressing the Enter key, your text becomes a bit-mapped image that may be manipulated with all the tools mentioned above. Headlines are best created in that way. Creating certificates is possible by duplicating and flipping clip-art

images to create a border, and then adding your text. In addition, First Publisher includes templates for several types of publications, including a newsletter, business stationary, a greeting card, and more.

PFS: First Publisher has two problems: its documentation and its tendency not to do what you tell it to do. The user's manual is very poorly organized, with some highly necessary information buried in obscure places. The book is well-indexed, however. In addition, it neglects to delineate proper layout procedure. Is it best to flow text first and add graphics later? (No.) Or should the graphics be placed, then the baselines defined, and then the text flowed? (Probably.) Should the basic layout (baselines and graphics placement) of each page—not just the first—be defined before flowing any text? (Absolutely.) The manual is no help in answering those questions.

The second problem is more insidious. Even after defining your baselines, which itself takes quite a bit of simple trial-and-error experimentation, text often does not follow your guidelines. And adjusting baselines after text and graphics have been placed is next to impossible.

In spite of those problems, First Publisher provides many of the capabilities of the big-name packages, as well as a unique graphics editor, at five or ten percent of their cost. If nothing else, First Publisher might be a good way to get your feet wet in desktop publishing. Many of the skills you'll learn will be transferable should you decide to upgrade to one of the power packages.

**THANKS**

Thanks to NEC Home Electronics for loan of a NEC MultiSync monitor, on which all photographs in this article and on this month's cover were taken.

## Inset

If you're interested in improving the quality of your presentations, but are unwilling or unable to invest the requisite time and money in a full-fledged desktop-publishing program, Inset may be for you. It's an ingenious package that allows you to integrate graphics and text, all within the confines of your regular word processor.

Inset runs on just about all IBM graphics adapters (CGA, EGA, and Hercules), and supports a variety of printers (IBM, Epson, Okidata, NEC, etc.), including several color printers and several laser printers. A mouse can be used, and is handy, but is not required.

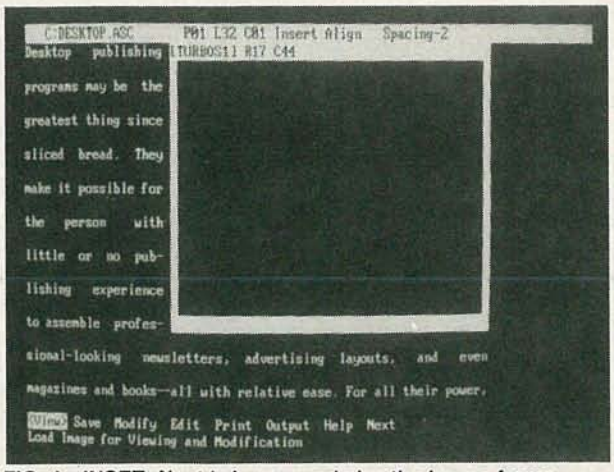


**FIG. 4—INSET: Next bring up and size the image frame.**

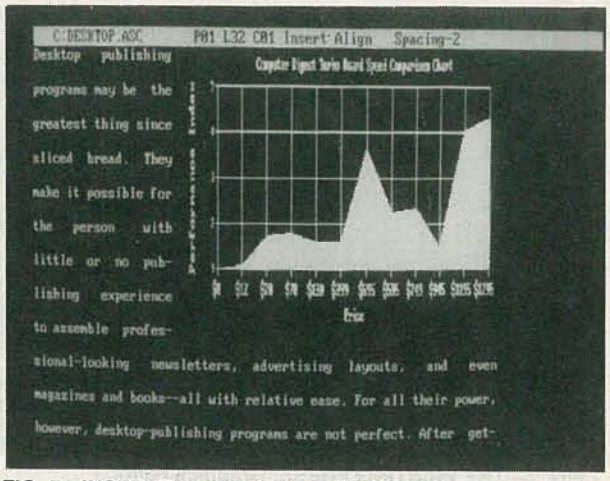


**FIG. 5—INSET: Then preview the final page.**

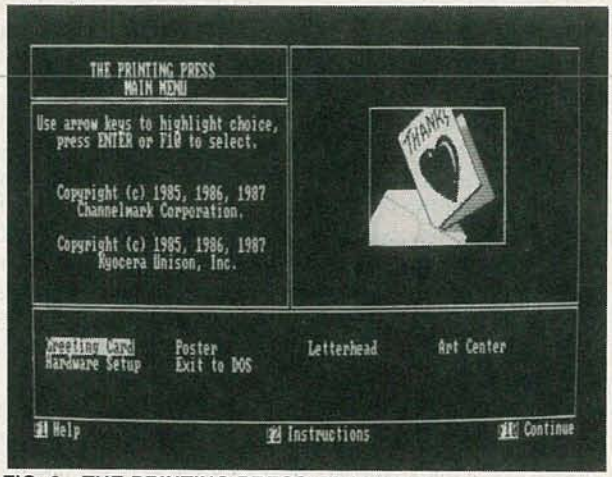


**FIG. 6—THE PRINTING PRESS: Main menu.**

You install Inset as a RAM-resident program that pops up when you press a hot key (normally PrtSc). The program requires from 35K to 115K of memory, depending on which options you enable. The smallest version only allows you to capture text or graphics screens from just about any program, including DOS, Lotus 1-2-3, dBASE, AutoCAD, etc. Those and other images may be edited later by the full version, which includes a fairly complete graphics editor.

You use your word processor to format your text, leaving a gap where the desired image will appear. Next you place the file name (surrounded by brackets) of the desired image in the upper-left corner of that area. (See Fig. 3.) Then, when you press the hot key, Inset will draw an outline on the screen showing where the image will appear, but not the image itself. (See Fig. 4.) At this point you can adjust the X and Y dimensions, independently or maintaining the original aspect (height to width) ratio. When the frame is the right size, you'll want to preview the actual image. (See Fig. 5.) If the size or the shape of the image is unacceptable, it's easy to modify either.

As for the image itself, you can create it from scratch within Inset, you can capture an image generated by another program—such as 1-2-3 graph, for example—and use it as is, or you can use Inset to modify a captured image from another package.

The text and graphics files are totally separate, but you print the text file using your word processor's usual print

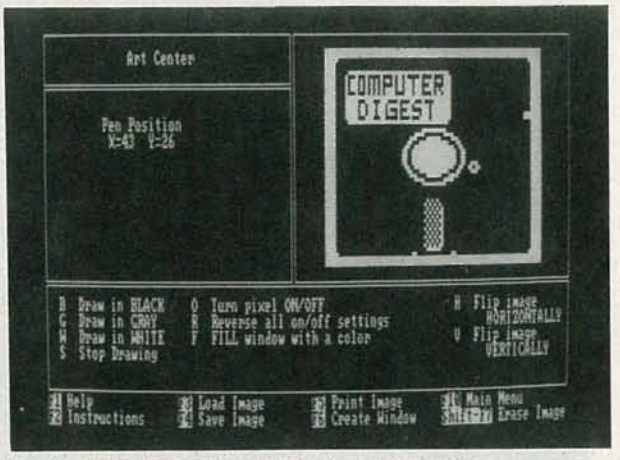


**FIG. 7—THE PRINTING PRESS: Graphics editor.**

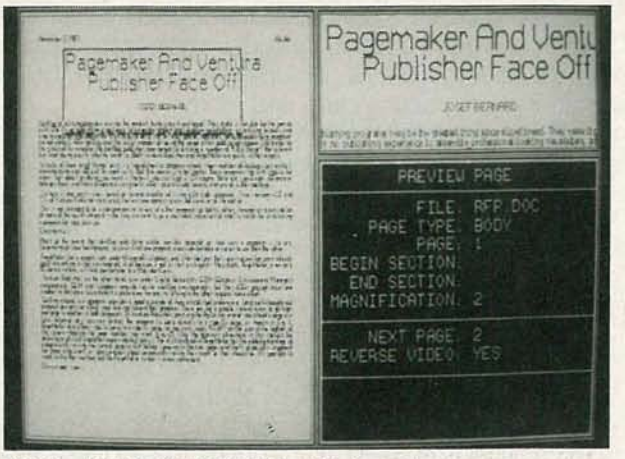


**FIG. 8—LOTUS MANUSCRIPT: Print preview screen.**

function. Meanwhile, Inset is lurking in the background monitoring all printer output, and when it sees the bracketed file name, it knows it's time to print the graphic image in the proper size, shape, and position. Color images are printed on a black and white printer by gray-scaling (simulating colors with various shades of gray).

Because of the way Inset works, it's best to use it with a word processor that displays text on-screen pretty much as it will appear on paper. WordStar 4.0 (which was used for our sample shots) works well; Inset systems also claims compatibility with DisplayWrite 2, DisplayWrite 3, MultiMate, Microsoft Word, Office Writer, Word Perfect, XyWrite II Plus, XyWrite III, and others.

The program and its drivers come on two floppy disks; a 150-page manual explains all operations. The manual includes a quick-start section for experienced users, and a brief tutorial for beginners.

### The Printing Press

By most people's definition, The Printing Press is not a desktop-publishing program, but because it allows you to integrate text and bit-mapped graphics, it fits ours. You use the program to create greeting cards, posters, and letterhead stationary. It runs on the Hercules monochrome graphics card, and on CGA compatibles (including EGA). Apparently the program was written for the CGA, and only crudely translated for the Hercules, because on the latter graphics are "squashed." That's not a serious problem, though, because images still print correctly. Supported printers include: IBM, Epson, Okidata, Toshiba, NEC, C. Itoh, etc.

The program is supplied on a single floppy disk; it includes a 111-image graphics library (other libraries are available at reasonable prices), eleven border styles, and ten text styles. Installation amounts to copying all files to a working disk, and then telling the program which graphics card and printer you'll be using. The Printing Press comes with a context-sensitive on-line help system, and an on-disk documentation file you can print yourself. To keep costs down, printed documentation is not included.

When you run the program, you're presented with the opening menu (shown in Fig. 6), from which you choose the type of publication you want to create, set up the hardware, exit to DOS, or enter the "Art Center," a graphics editor. You navigate menus using the cursor keys, and make your selection by pressing the Enter key.

To make a poster, for example, you choose that item from the main menu, after which you're presented with the Poster Design Elements menu. There you choose a border style, one or two graphics images, their placement, and the text of your poster. Text can appear in ten different type styles, each of which may appear in one of two different sizes, and in one of five "textures" (standard, outline, checkered, etc.).

You can place graphic images in one of three sizes (regular, half-size, and double-size). Double-size images are centered on the design for you automatically; you have some control over how (and how many) images are placed in the other sizes, or the program will place them for you in one of several ways.

Last, you preview your design and then print it. Or you can return to the editing screens and further modify the images and text. When everything is as you want it, you can save the image to your working disk.

The Art Center (shown in Fig. 7) provides a rudimentary graphics editor that allows you to turn individual "dots" on and off, flip an image horizontally and vertically, reverse it (black to white and vice versa), and more. There is no provision for creating even simple shapes (lines, boxes, circles) or text other than dot by dot. You can create you own images from scratch or modify those in the supplied library. Each image is composed of an 88 × 52 array of dots.

#### FOR FURTHER INFORMATION

The best single source of information we have seen that covers all aspects of publishing (not just the desktop variety thereof) is *The Illustrated Handbook of Desktop Publishing and Typesetting*, by Michael L. Kleper, c. 1987, Tab Professional Books, P.O. Box 40, Blue Ridge Summit, PA 17214.

The graphics department of your local college or university is another good source of information.

The explosion of the desktop-publishing industry has spawned a slew of magazines devoted to the field, many of which are not worth the paper they're printed on, and probably won't be in print very long. The best of the lot are *Personal Publishing* (Hitchcock Publishing Company, 25W550 Geneva Road, Wheaton, IL 60188-2292, 312-665-1000) and *Publish!* (PCW Communications, Inc., 501 Second St., San Francisco, CA 94107, 800-222-2990, 415-243-0600). PC World and Mac World magazines (also published by PCW) also carry desktop-publishing features occasionally.

It takes a fair amount of trial and error to get things right, because you don't see whether your image(s) will interfere with your text until you go to the preview screen. Your text, for example, could overlay an image and thereby be indecipherable. However, after creating a few designs, you get a feel for how much space images and the various text fonts occupy, so you can then plan your designs accordingly.

The only real problem with the program is the way you must select an image by scrolling through list after list after list of images in the currently selected set. It would be much more convenient to be able to select an image by name. In addition, you don't know what an image looks like until you select it. Another great convenience would be a way of printing an entire graphics library (with image names) at once.

**Manuscript**

This product from Lotus Development Corporation attempts to combine three products in one: word processor, outliner, and graphics integrator. The latter capability is what qualifies Manuscript for inclusion here.

Unlike most desktop-publishing programs, Manuscript is intended for use at each step of the documentation process. You can take notes and subsequently rearrange them using the outliner, write and edit your text with the editor, and then print your document on a wide range of dot-matrix and laser printers.

Your documents can include several types of graphics elements: tables (with ruled lines); graphs imported from 1-2-3, Symphony, and other programs; equations, which you enter using a special equation-description language; and several others (including scanner and PostScript files). Describing an equation is straightforward. For example, the equation:

$$A^2 + B^2 = C^2$$

would be entered using a Manuscript "backslash" command as:

\equation A super 2 + B super 2 = C super 2\

**PRODUCTS DISCUSSED**

- PageMaker ($695), Aldus Corporation, 411 First Avenue South, Seattle, WA 98104, 206-622-5500.
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- Xerox Ventura Publisher ($895), Xerox Corporation, P.O. Box 24, Rochester, NY 14692, 800-832-6979.
  **CIRCLE 22 ON FREE INFORMATION CARD**

- The Printing Press ($49.95), Power Up!, 2929 Campus Drive, P.O. Box 7600, San Mateo, CA 94403, 800-851-2917, 800-223-1479 (CA).
  **CIRCLE 23 ON FREE INFORMATION CARD**

- Inset ($99.95), Inset Systems, 12 Mill Plain Road, Danbury, CT 06811, 800-828-8088, 203-794-0396.
  **CIRCLE 24 ON FREE INFORMATION CARD**

- PFS: First Publisher, P.O. Box 7210, 1901 Landings Drive, Mountain View, CA 94039-7210, 415-962-8910.
  **CIRCLE 25 ON FREE INFORMATION CARD**

- Lotus Manuscript Lotus Development Corporation, 55 Cambridge Parkway, Cambridge, MA 02142, 800-345-1043, Lot No. QA-1450.
  **CIRCLE 26 ON FREE INFORMATION CARD**

Although a wide range of printers is supported, the bit-image capabilities of dot matrix printers are not used for text reproduction (as PageMaker, Ventura, and PFS can do), so only a printer's native text fonts are available. That means you won't be able to print half-inch headlines, italicized type, or Greek letters on a dot-matrix printer that doesn't have those capabilities built-in.

The editor is fast, but you don't get a WYSISWYG (What You See Is What You Get) display for either text of graphics, so you don't know where page breaks occur until you either print or preview the document.

The basic procedure for integrating a graphics image with a document is simple. To include a 1-2-3 graph, for example, you have to enter another backslash command of the form:

\picture filename\

The column where the command is located determines where the image will appear, and the command itself allows you to scale the image horizontally and vertically. But to see how the image appears on the page, you must do a print preview, as shown in Fig. 8. An overview of the page is shown on the left side of the screen; you can magnify a portion of the image by moving the box (shown in the upper left corner of the page image) around using the cursor keys. The current contents of the magnifying glass are shown in the upper right corner of the display.

Manuscript is supplied on eight floppy disks, whose contents occupy more than two megabytes of space. You can delete unnecessary printer and screen drivers to reduce that to about 1.5 megabytes. Two well-produced manuals (tutorial and reference) are included. The editing and outline functions work fairly quickly on a standard XT, but to preview pages on-screen, you'll want an AT-class machine, on which the preview process is by no means instantaneous.

**Conclusions**

Each of the programs discussed in this article is a quality product, with its own strengths and weaknesses, and whose capabilities overlap the others in some areas. The Printing Press, for example, is by far the easiest to use, but has the lowest quality output. At the other end of the scale, it would be overkill to use Ventura Publisher to make a "Garage Sale" sign. A good compromise is PFS: First Publisher, which can provide fairly high quality output, but which requires a heavier investment in learning and usage time. For example, you'll have much better control over graphics and text placement with PFS than with Printing Press, but you'll have to spend time doing that placement—and it adds up quickly.

To produce a semi-formal report for school or business, Inset is hard to beat because of its ability to capture and edit images from a multitude of programs, and then include those images in your report.

Lotus Manuscript could be the ideal solution for the professional technical documentation specialist working with (and converting files to and from) several packages (outliner, word processor, and print formatter). The integrated environment, along with Manuscript's ability to work with really large documents, make it highly attractive to the user. Next time, we'll see how two of the heavyweights—Pagemaker and Ventura Publisher—fare in a head-to-head competition.

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# BUILD THE PT-68K

*Add keyboard and video this time.*

Copyright 1987, Peter A. Stark

**PETER A. STARK,**
STARK SOFTWARE SYSTEMS CORPORATION

**Part 5** We quit last month just when HUMBUG (our monitor in ROM) signaled that it was working by sounding a "beep-boop" tone. Now let's connect a keyboard and a video display to the computer so we can communicate with HUMBUG.

### One step backward

In order to get that beep-boop sound, we rushed the last few steps and mounted a few parts without explaining why, so let's retrace our steps and see what we did.

In Step 13 last time, we installed four 10K resistors, an MC68681 DUART, and a 3.6864 MHz oscillator. The four resistors (R9, R10, R12, and R13) are needed because we want to use the computer before wiring is complete; they would not be needed if the entire system were completed. (They do no harm if used.)

As shown in Fig. 5 last time, the $\overline{\text{DTACK}}$ generator contains an eight-input gate, IC36, that generates $\overline{\text{DTACK}}$ when any input is brought low. Presently, four of those inputs (pins 1, 2, 3, and 12) are not connected to anything, because there is no DRAM, no hard disk, no serial port, and no XT expansion port. It's not a good idea to leave those inputs floating, so the resistors hold the inputs high, and thereby prevent generation of a false $\overline{\text{DTACK}}$.

The MC68681 DUART (IC10), along with the 3.6864-MHz oscillator (IC3) are used mainly for serial communications. However, the DUART also has an internal counter/timer that is used to generate the tones for the speaker. The circuit is shown here in Fig. 1; only one wire (the connection to pin 13 of IC10) is used by the speaker circuit. We'll discuss how the DUART works shortly.

### Communicating with the PT-68K

Now we're ready to install the I/O (input/output) circuitry that will allow us to communicate with the computer via a keyboard and some sort of video display. There are several possible ways of doing so.

1. A "dumb" computer terminal with a serial (RS-232) interface (such as a Televideo, a Soroq, etc.). Often you can buy a serial terminal for a good price at a computer flea market or from a surplus dealer.

2. A personal computer (IBM PC, Apple II, Commodore, etc.) that can emulate a dumb terminal. Many telecommunications programs for PC's have terminal-emulation modes that will allow the computer to emulate one of several different terminals.

3. Last, because the PT-68K has IBM PC-compatible expansion connectors, and an IBM-compatible keyboard port, you can use inexpensive IBM clone components (video adapter, monitor, and keyboard).

Using a terminal or a computer emulating a terminal is easy: just install a serial port on the PT-68K by adding two IC's and a connector. The procedure is discussed in Step 14 later on in this article.

The keyboard and PC interface circuitry, however, is more complex and requires an additional hardware kit (PT-5a, available from Peripheral Technology, 404-984-0742), so it is optional. If you do not wish to install it now, you can do so later at any time. Adding the IBM-compatible slots and components is discussed in Steps 15 and 16.

The components for the serial interface are part of the basic kit, so you might as well install them even if you do not use a serial terminal, because you may in any event use a serial printer or a modem.

### Step 14: The serial ports

Figure 1 shows the circuitry for the PT-68K's four serial ports. DUART IC10 drives the two primary ports, and IC4 drives the two optional ports. Resistor R9, 3.6864-MHz oscillator IC3, and MC68681 DUART IC10 have already been installed, so at this point we need only add IC29, IC30, J21, and J22 to finish installing the circuitry for the two primary ports.

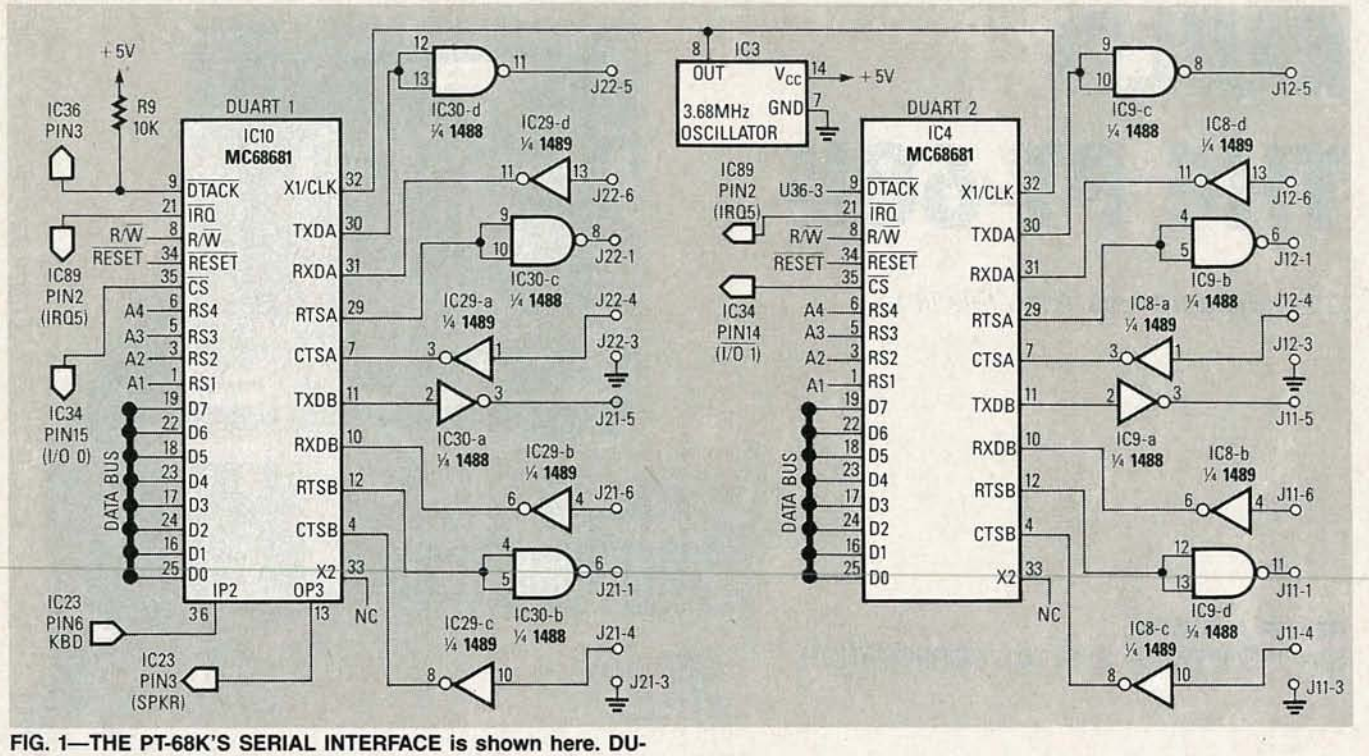


**FIG. 1—THE PT-68K'S SERIAL INTERFACE is shown here. DUART IC4 and associated components are optional.**

## MC68681 operation

DUART is an acronym for Dual Universal Asynchronous Receiver-Transmitter; the IC converts data between parallel form (as the microprocessor uses it and as it travels along the data bus) and serial form (used to link printers, plotters, modems, and other peripheral devices).

Although the DUART performs many of the same functions as a traditional UART (serial-to-parallel and parallel-to-serial conversion), it also does much more. Not only does it contain two internal receiver/transmitter ports and a baud-rate generator, but it also contains a multi-function six-bit parallel input port, an eight-bit output port, and a 16-bit programmable timer/counter. The PT-68K system software ignores most of the extra functions, but it does use bit 3 of the output port (pin 13, called OP3) and the programmable counter/timer to drive the speaker, and bit 2 of the input port (pin 36, called IP2) to monitor the PC-compatible keyboard interface.

As shown in Fig. 1, the connections to the computer (on the left of IC10) are straightforward. The clock signal comes from IC3, the 3.6864-MHz oscillator module that we installed last time. The $\overline{\text{DTACK}}$ output connects directly to IC36 (shown in Fig. 5 in the January 1988 installment); the $\overline{\text{IRQ}}$ output connects to $\overline{\text{IRQ5}}$, the level-five IRQ input (shown in Fig. 2 in the December 1987 issue); R/$\overline{\text{W}}$ and $\overline{\text{RESET}}$ connect to corresponding signals elsewhere; and $\overline{\text{CS}}$, the chip-select input, connects to $\overline{\text{I/O0}}$ (pin 15 of IC34, shown in Fig. 3 in the January 1988 issue). As discussed in that installment, $\overline{\text{I/O0}}$ goes low any time the microprocessor tries to access an address between $FE0000 and $FE003F.

The DUART's data pins connect to the lower eight bits of the data bus, and the four register-select lines (RS1–RS4) connect to the low-order address lines (A1–A4), respectively. The four register-select lines allow access to sixteen ($2^4$) addresses. However, because only the lower eight bits of the data bus are used, those sixteen addresses are all odd, so the DUART is addressed at $FE0001, $FE0003, $FE0005, and so on, through $FE001F. (The second DUART, IC4, is addressed at $FE0041 and above.)

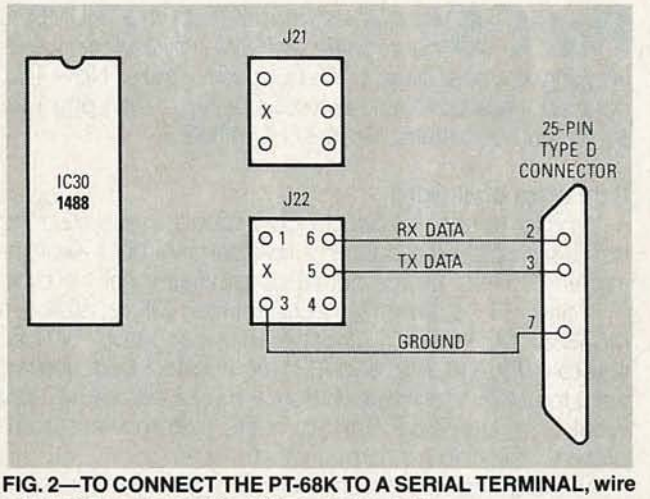


**FIG. 2—TO CONNECT THE PT-68K TO A SERIAL TERMINAL, wire a 25-pin D connector to J22 as shown here.**

Internally, the DUART contains almost two dozen registers, some of which can be read from and some of which can be written to by the 68000. It takes Motorola about 70 pages to explain the DUART in the MC68681 data sheet (Motorola publication ADI-988, available from Motorola distributors or from Motorola Semiconductor Products, 3501 Ed Bluestein Blvd., Austin TX 78721), so there is no way to do it justice here. Instead, let us just list a few of the important addresses. The DUART contains two serial ports, called port A and port B. The following addresses are for port A, the port used for a terminal.

$FE0007 is the data register. Sending a byte to that address outputs it to the first serial port (J22); a character input from the port can be read at the same address.

$FE0003 is used to determine whether the DUART is

ready to send or receive a character. The bits at this address are numbered from 0 to 7, with bit 7 on the left and bit 0 on the right. Bits 0 and 2 are most important. If bit 0 is a 1, then the DUART has received a character from the serial port, and the character can be read from $FE0007. If bit 2 is a 1, then it is ready to output a character to the serial port, so you can store that character in $FE0007.

Port A's baud rate is determined by the value stored at $FE0003. HUMBUG automatically recognizes the baud rate of your keyboard and sets the DUART's baud rate to match. (HUMBUG supports baud rates of 300, 600, 1200, 2400, 9600, and 19,200 baud.) Allowable DUART baud rates and also their corresponding register values are shown in Table 1.

**TABLE 1—BAUD RATE**

| Baud rate | Register value |
|---|---|
| 110 | 11 |
| 300 | 44 |
| 600 | 55 |
| 1200 | 66 |
| 2400 | 88 |
| 4800 | 99 |
| 9600 | BB |
| 19200 | CC |

Addresses $FE0005 and $FE0015 can cause problems. The Motorola DUART data sheet states, "Do not access—this address location is used for factory testing of the DUART and should not be read. Reading this location will result in undesired effects and possible incorrect transmission or reception of characters. Register contents may also be changed." Accidentally reading this location may cause your PT-68K system to crash, so be careful!

Referring to Fig. 1, there are four active signals and one ground for each port. Port A (the terminal port) has a signal labeled TXDA (pin 30), which stands for Transmitted Data. As you might guess, RXDA (pin 31) stands for Received Data. The corresponding signals in Port B are called TXDB and RXDB, respectively.

RTSA (pin 29) is the Request To Send line, which is used to tell an external device that it's OK to send data. CTSA (pin 7), on the other hand, is the Clear To Send line; the external device can use it to tell the computer that it's OK to send data. Normally, PT-68K software ignores both RTS and CTS lines.

Now mount the following parts: socket for IC30 (1488 TTL-to-RS-232C converter) at IC30; socket for IC29 (1489 RS-232C-to-TTL converter); and two six-pin dual-row header strips at J21 and J22. As shown in Fig. 2, cut off one pin and position the header so that the side missing the pin is closest to IC30. Install IC29 and IC30.

Figure 2 also shows how to connect a terminal to the six-pin header. On the terminal end, you will need a DB-25S connector with wiring to pins 2, 3, and 7 as shown. On the computer end, you will need a special connector made by Berg and others (and supplied as part of the PT-68K basic kit). First, crimp (or lightly solder) a Berg 47747 pin on the end of each wire, then insert the three pins into the top end of a Berg plastic shell number 65043-034. Then insert a 65307-001 key (a plastic insulating pin) into the hole corresponding to the cutoff pin (labeled "X" in Fig. 2) to ensure that the connector can't be inserted backward. Don't insert extra pins in the remaining holes, because they cannot be connected to or removed after they have been installed.

### First test

If you do not have a serial terminal (or a computer emulating a terminal), then skip ahead to Step 15; otherwise keep going.

Now connect the DB-25S to the terminal, the Berg connector to J22 (not J21!), and turn on the power. Wait until the beep-boop tone is finished, and then press the Return (or Enter) key on your terminal once or twice. If all goes well, the terminal should display HUMBUG's sign-on message and prompt.

If the sign-on message does not appear, it's likely that there is a minor problem with the terminal wiring. First, set the terminal to either 300 or 1200 baud. Then, with a scope or meter (don't use the LED probe from J14-1 or you may damage IC32) check the voltage on the RXDATA and TXDATA lines at J22; they should both be negative, between −3 and −15 volts. If the TXDATA line is negative but RXDATA is not, then try swapping the two connections at pins 2 and 3 of the DB-25S connector—both the computer and the terminal may be sending data to the same line. If both lines are negative, check that pressing a key on the terminal makes the voltage on the RXDATA line swing from negative to positive and back; a scope will show this quite clearly, whereas a meter may just show a slight amount of wavering. A steady low on TXDATA probably means that some control lines (usually pins 5, 6, 8, and 20) should be connected together.

Apart from possible problems with IC29 and IC30 (which may not be passing either the received or transmitted signal), there are few other things that could be wrong, because at this point the remainder of the circuit (including IC3 and IC10) must be working, otherwise the speaker wouldn't have beeped. However, if you're still having problems, check IC3 anyway—if it is defective, IC10 might be picking up just enough noise that the speaker works, yet the serial port does not.

If you intend to install the PC-compatible keyboard and expansion connectors, continue on with Step 15; otherwise, skip ahead to Step 17.

### Step 15: The PC-compatible keyboard

PC-compatible keyboards are very different from the average computer keyboard in that they contain quite a bit of internal intelligence (including a buffer that stores keystrokes the computer hasn't yet accepted). Yet they do not generate an ASCII code for each key. Such keyboards require a fairly complex interface circuit, which is shown in Fig. 3, as well as a fairly complex program to decode key codes.

The keyboard connects to J9 via a five-pin DIN connector that carries ground, +5 volts, and $\overline{\text{RESET}}$ signals to the keyboard, and carries the $\overline{\text{CLOCK}}$ and DATA signals to the computer. Note, however, that both $\overline{\text{CLOCK}}$ and DATA are bidirectional, so the PT-68K can send signals to the keyboard via those same lines.

When the computer is turned on or reset, pin 11 of IC32-e (BRESET) goes high. That signal is inverted and sent to the keyboard via the $\overline{\text{CLOCK}}$ line, and that resets the keyboard. If your keyboard has CapsLock and NumLock lights, you'll see them flash when the keyboard is reset.

The system $\overline{\text{RESET}}$ signal is also sent to the keyboard; that

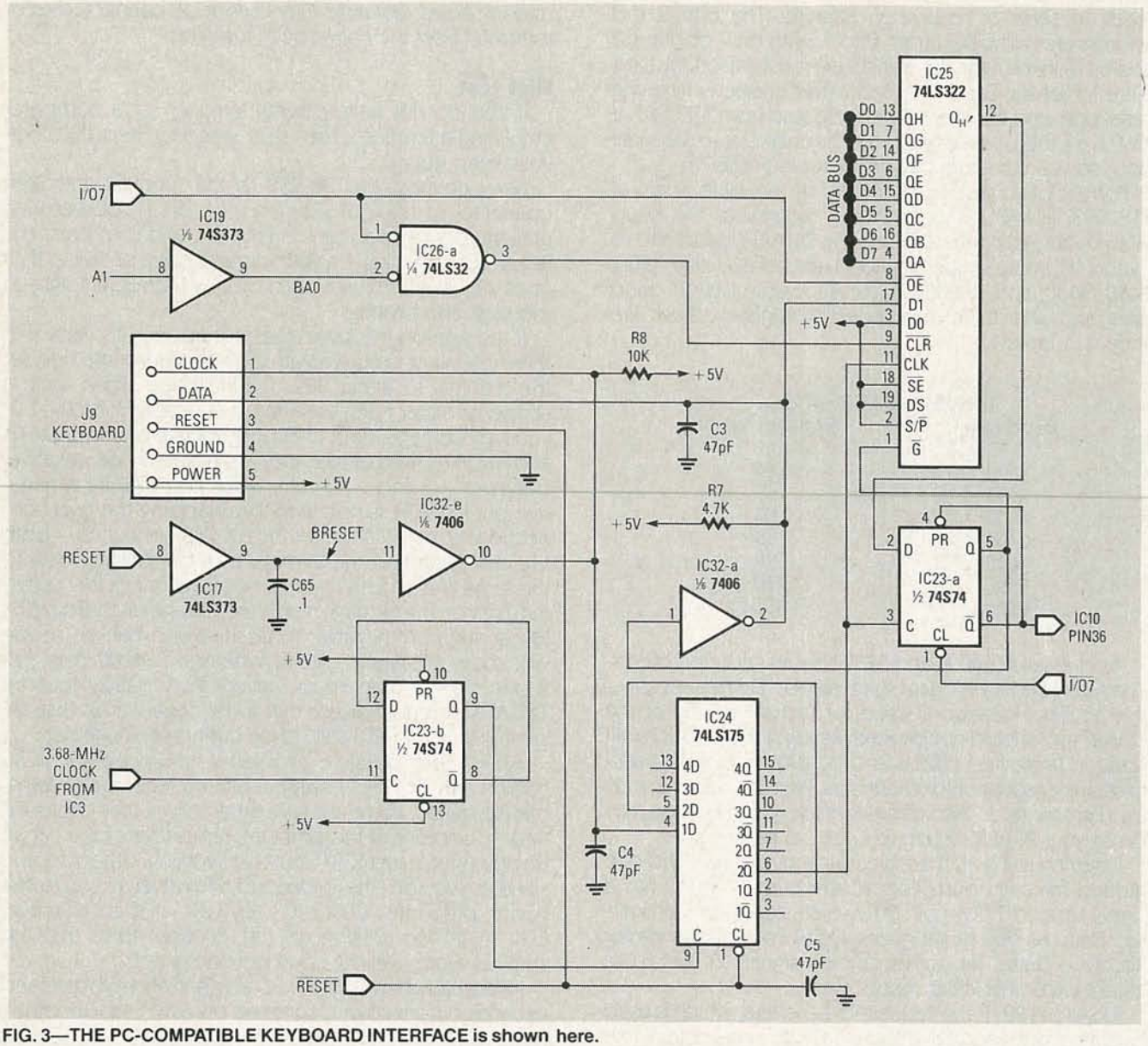


**FIG. 3—THE PC-COMPATIBLE KEYBOARD INTERFACE is shown here.**

signal simultaneously clears IC24, a quad D flip-flop. Meanwhile, HUMBUG reads the keyboard by asserting $\overline{\text{I/O7}}$ (shown in the address decoder circuit, Fig. 3 in the January 1988 installment), and that read clears IC23a, which drops its Q output low. That signal then enables IC25 via pin 1, $\overline{G}$, and it also goes to pin 1 of IC32a, which open-circuits its output and lets the keyboard's DATA line swing high or low, as needed. At the same time, the $\overline{Q}$ output of IC23-a, which is high, goes to the IP2 input of the DUART (IC10).

Meanwhile, the 3.6864-MHz output of IC3 (the DUART's clock generator) also goes to IC23-b, where it is divided by 2 to produce a 1.8432 MHz signal, which in turn clocks IC24, which is wired as a shift register.

To understand the significance of all that, suppose you press (or release, as we'll see) one of the keyboard keys. The keyboard sends out a key number (not an ASCII code) on the DATA line in serial form, and simultaneously pulses the $\overline{\text{CLOCK}}$ line, once for each bit. The data is sent to the D1 input of IC25, a 74LS322 shift register. At the same time, the $\overline{\text{CLOCK}}$ signal sends a low pulse to the 1D input of IC24, whose first two flip-flops are also wired as a shift register.

After two pulses of the 1.8432-MHz clock (a delay of about 1 microsecond), a high comes out the $\overline{2Q}$ output and clocks both IC23-a (flip-flop) and IC25 (shift register). The data bit then enters the first stage of the shift register, and a moment later the $\overline{\text{CLOCK}}$ signal goes high again.

This process is repeated once for each keyboard data bit, with the data bits proceeding through IC25, from QA to QB, QC, and so on, until the first bit gets to the last flip-flop, at which time a high comes out $Q_{H'}$ (pin 12) and is sent to the D input of IC23-a. That bit is always a 1, but it is immediately discarded because the next clock pulse shifts it out of IC25. It is there long enough, however, to make IC23-a set at the next clock pulse.

When that occurs, the flip-flop does four things: (a) its $\overline{Q}$ output goes low and sends an interrupt request to DUART 1, which relays it to the 68000; (b) the same low forces IC23-a to stay set in case there are more clock pulses; (c) the Q output sends a high to the $\overline{G}$ input of IC25, which prevents it from shifting further; and (d) the same

high is inverted by IC32-a into a low, which grounds the keyboard's DATA line and prevents the keyboard from sending further data.

Assuming that DUART 1 is properly programmed, the interrupt request goes to the 68000, which then stops its normal processing and goes into a special routine, called an *I*nterrupt *S*ervice *R*outine (ISR), to accept the input from the keyboard. That routine is part of HUMBUG; when invoked it reads a byte from location $FE01C3, which pulses the $\overline{I/O7}$ line. That clears IC23-a and pulses the output enable ($\overline{OE}$) pin of IC25, which then sends the received data byte to the data bus to be read by the 68000. The 68000 thus gets the data byte output by the keyboard.

A few microseconds later, the ISR reads location $FE01C1, which pulses the $\overline{I/O7}$ line a second time, but with a difference. On the first read (from $FE01C3), A1 (and BA0, which is the same as A1 but buffered by IC19) was a 1, but on the second read (from $FE01C1) that signal is a 0. The reason is that C3 ends with 0011 whereas C1 ends with 0001; the second bit from the right is A1, which now is a zero. Hence, on the second read, IC26-a receives two low inputs at the same time, so it outputs a low to IC25's $\overline{CLR}$ input, which resets IC25, and prepares it ready for the next keystroke.

Rather than providing a specific ASCII character for each key, PC-compatible keyboards send a scan code when a key is pressed, and a different code when it is released. Since the circuit generates an interrupt request for each such code, the ISR in HUMBUG is called each time a key is pressed or released; that routine must convert those codes into ASCII depending on the state of the shift, Ctrl, NumLock, and other keys. (For more information on PC keyboards, see *A Programmer's Guide to the IBM PC*, by Peter Norton, published by Microsoft.)

Now install the following components: R7 (4.7K), R8 (10K), IC23 (74S74) and socket, IC24 (74LS175) and socket, IC25 (74LS322) and socket, IC17 (74LS373) and socket, IC19 (74S373) and socket, three 0.1 µF disk capacitors at C8, C9, and C10; and J9, the keyboard connector. (IC26, IC32, and the three 47-pf capacitors were installed previously.) Check your work and then turn on the power to the system.

If you have a serial terminal connected, then testing the PC keyboard circuit is easy. Set the terminal to 2400 baud (HUMBUG's default rate), turn on the power, wait for the beep-boop, and press the Return key on the PC keyboard. You can now use that keyboard for input, but will see all output on the serial terminal.

If your terminal does not run at 2400 baud, you can change the baud rate from the PC-compatible keyboard as follows. (You must have heard the beep first.)

**1.** Type the following exactly as shown: MSFE0003
**2.** Press the space bar once.
**3.** Type in the baud rate code listed Table 1.

For example, to change the baud rate to 9600 baud, type in MSFE0003spaceBB (press the space key—don't type the word *space*.) That enters the value BB in the baud-rate register of the DUART at location $FE0003.

Without a serial terminal, you have two choices: either use an oscilloscope or a logic probe to check various signals in the circuit, or else go on to Step 16, and test the keyboard after a video board is installed. The latter is probably easier.

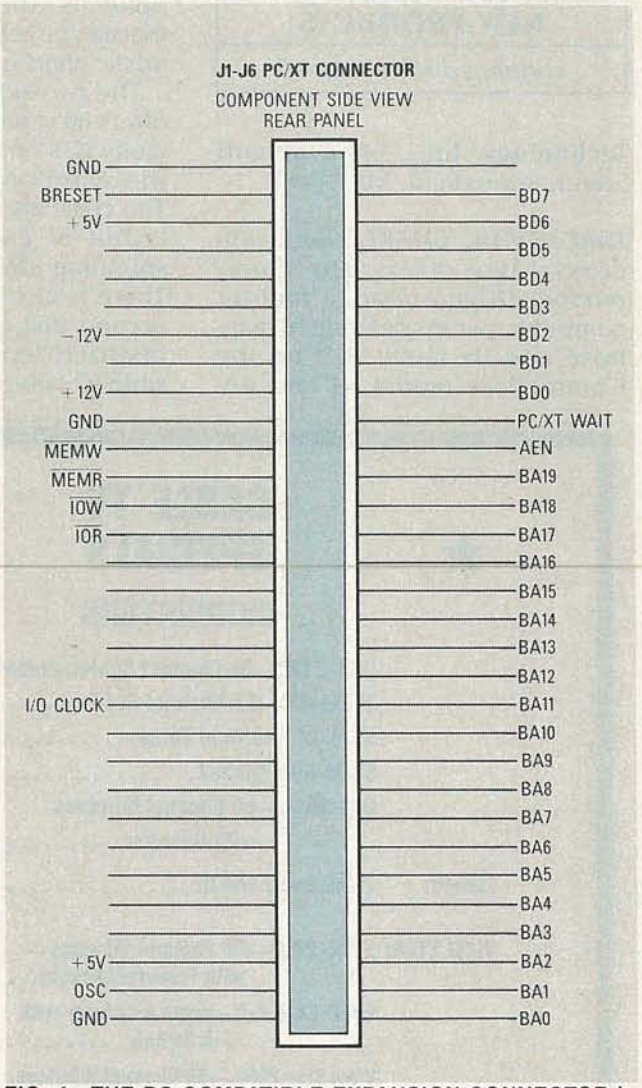


**FIG. 4—THE PC-COMPATIBLE EXPANSION CONNECTOR is shown here. Unmarked pins are used by a PC, not the PT-68K.**

## Step 16: The PC-compatible bus connectors

You can mount as many as six 62-pin PC-compatible card-edge connectors at the left rear corner of the PT-68K motherboard. You can install almost any PC- or XT-compatible plug-in I/O card, but cards intended for AT-type slots will not work.

At this time, the PT-68K software supports only the monochrome and CGA color video boards, and the WD1002A-WX1 hard disk controller, but it is fairly straightforward to write software for other cards as well. Also, our software does not support other popular expansions cards, including floppy-disk controllers, serial and parallel I/O cards, clock/calendar boards, or multi-function boards that combine several of the above; those I/O options are available on the PT-68K motherboard itself.

Although there are many hard-disk controllers available for PC's and clones, SK*DOS (the PT-68K disk operating system) currently supports only the Western Digital WD1002A-WX1 controller. Figure 4 shows the pinout of the PC-compatible expansion connector. All of the labeled pins are used; the unlabeled pins are not needed in a 68000 system. Some of the pins, such as ground or power, are obvious; the other connections will be discussed when we continue next time.

## NEW PRODUCTS

*continued from page 42*

**Technology, Inc.,** 144 Oakland Street, Springfield, MA 01108.

**DIAGNOSTIC CHART.** Kasara Microsystems offers *The Commodore Diagnostician,* a tool for computer owners desiring to diagnose and fix faulty IC's on the Commodore model *64* and peripherals. The cure rate of repair that can be achieved with this diagnostic chart is 95%.

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THE COMMODORE DIAGNOSTICIAN

A symptomatic chart for diagnosing faulty IC components on Commodore Computers and peripherals

By: IAN PERRY, MA
PO Box 48
Kyneton
Victoria 3444
Australia

COMMODORE C-64
*Reference Aid #4*

| SYMPTOMS | POSSIBLE SOLUTION | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 6510 | 6526 | 6581 | 6567 | PLA | ROM 326 | ROM 327 | ROM 329 | ROM 8701 |
| Cursor jumps back to home position | X | | | | | | | | |
| Abnormal colours appear in the letters | | | | | X | | | | |
| Different characters are displayed and cursor is locked when turned on and off | X | | | | X | | | | |
| System does not reset and the 'RESTORE' key does not work | X | | | | | X | | X | |
| Cursor disappears after the system warms up | | X | | | | | | | |
| SYNTAX ERROR displayed after system warms up | | | | | | X | | | |
| The system resets when it warms up and long programs do not load | X | | | | | X | | | |
| Keyboard does not operate correctly when the system warms up | | X | | | | X | | | |
| Cassette motor keeps running | X | | | | | | | | |
| The cursor disappears when the cassette is plugged in | X | | | | | | | | |
| Cassette runs extremely slow. The program seems to load but will not run | X | | | | | | | | |
| Blank screen on power up | X | | | | X | X | | | X |
| No cursor displayed. Intermittent blank screen. Intermittent graphics | X | | | | | | | | |
| Powers up with 'PRESS PLAY ON TAPE' message and the display blanks | X | | | | | | | | |
| On power up the cursor locks up | X | | | | | | | | |
| When 'RETURN' is pressed after a run command, the cursor goes back to home position | | | | | | | X | | |
| Poke command does not work | | | | | | | X | | |
| Joystick does not operate correctly | | X | | | | | | | |
| No character lettering is displayed on the screen | | X | | | X | X | | X | |
| Graphic characters instead of letters displayed | | X | | | X | | | | |
| Power up message appears but no cursor | | X | | | | | | | |
| DEVICE NOT PRESENT ERROR is displayed when disk is used | X | X | | | | X | | | |
| Disk drives continue to search when trying to load | | X | | | | | | | |
| Incorrect screen colours or no colour at all | | | | | X | X | | | |
| Keyboard does not function | | X | | | | | | | |
| Cassette recorder problem | X | X | | | | | | | |
| Flashing colour or blanks | | | | | | X | | | |
| Game Cartridge does not function | | | | | | X | | X | |
| Unit dead (30-40% possibility PLA) | | | | | | X | | | |
| User port does not function (eg. modem) | | X | | | | | | | |
| Not sound | | | X | | | | | | |
| Missing notes | | | X | | | | | | |
| Game paddles do not function | | X | X | | | | | | |
| White band scrolls down the screen (50 HZ HUM) | Check power supply and VR2 regulator | | | | | | | | |
| Wavy screen after the system warms up | Check external power supply and 6567 chip | | | | | | | | |
| Black band scrolls through screen when system warms up | Check external power supply and VR2 regulator | | | | | | | | |
| Out of memory error on power up | Check Rams 4164 U1-U12. U31-U34 | | | | | | | | |
| Powers up with graphic display and blinking cursor | Check U14 | | | | | | | | |
| Powers up with all the characters displayed as blocks | Check U26 | | | | | | | | |
| Unit completely dead | Possible power supply failure | | | | | | | | |
| After a few minutes, characters are all over the screen. Then the unit locks up | Possible power supply problem | | | | | | | | |

Note: PLA chip is an 82S100. ROM chips are 901227-01 (Basic), 901227-02 (Kernel), 901225-01 (Character).

CIRCLE 17 ON FREE INFORMATION CARD

*The Commodore Diagnostician* diagnostic chart is priced at $6.95 plus $1.00 for shipping and handling.—**Kasara Microsystems, Inc.,** 33 Murray Hill Drive., Spring Valley, NY 10977.


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CIRCLE 201 ON FREE INFORMATION CARD


## HARDWARE HACKER

*continued from page 78*

for modelmaking and for breadboarding. Free samples are available for you to examine.

Meanwhile, the folks at Lindsay Publications have an amazing collection of books on everything from machine shop practice to perpetual motion machines to Telsa stuff to reprints of some very early shortwave-radio construction projects. Virtually everything they stock is useful and hands-on. Many of their books are reprints of "lost" mechanical and electrical art that are from long ago and far away.

Several of you hackers have asked how to really get started into the fundamentals of microprocessors and microcomputers. By one of those absolutely astounding coincidences, I just happen to have written my own *Micro Cookbooks, Volumes I and II.* I do have a few autographed copies in stock here at Synergetics for you.

Send all your contest entries directly to me. Entry or not, let's hear from you soon on our brand new help line. R-E

## AUDIO UPDATE

*continued from page 80*

bringing the matter full circle. Needless to say, I'm still not absolutely sure what Gamma-Plus was supposed to accomplish.

### Skewed priorities

I could provide other examples of the very low priority that many audio companies place on clear, accurate, and timely communications. Their *high* priority is usually on promoting their annual special technical gimmick—such as Gamma-Plus. Next year, Gamma-Plus is likely to be forgotten in favor of, say, a revolutionary "Lateral-Feedback circuit that prevents signal side-slip, a newly discovered source of semi-audible distortion." And it isn't just instruction manuals that suffer from the original manufacturers' skewed priorities. Many of the illiteracies and silliness seen in the ads and promotional literature arise from the same problem. The equipment is obviously designed by talented professionals—so why do the manuals so often appear to be the work of incompetent amateurs?

There's no single answer to that question. Incompetent engineers don't last long, but incompetent technical copywriters apparently go on forever. Too many Far-Eastern manufacturers have on-staff technical writers who, on one hand, are overly dependent on "The Concise Japanese-English Dictionary", and on the other, are too prose-proud to accept criticism. The U.S. subsidiaries are then stuck with whatever their parent companies supply.

If anyone thinks I'm exaggerating the instruction manual problem, all they need do is interview a batch of customers who have recently bought new and/or more-complex components. Or read the mail that comes in to any of the major hi-fi magazines. Much of the mail is from readers seeking information on matters that should have been explained in the instructions that accompanied their new equipment. It's obvious that overseas manufacturers (and some from right here at home) should pay closer attention to their manuals. Perhaps the only way that will come about is if they are deluged by complaints. If a newly bought component seems impossible to hook up with the instructions provided, don't assume that *you* are to blame. **R-E**

*But you didn't follow the testing equipment's operating manual. It states step 3 comes after step 4!*

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CIRCLE 187 ON FREE INFORMATION CARD

# NEW IDEAS

## Parasitic signaller

I WAS OFTEN CUT OFF FROM THE OUTside world when working in my basement shop. I couldn't hear when I was being called for dinner, didn't know if a telephone call was for me, or if the doorbell had just rung and no one else was home to answer it. To solve this problem in communications with the rest of the family, I built a "parasitic signaller" that made the doorbell circuit do double-duty as both an annunciator and as a communications system.

The device is a simple assembly of junk-box parts that produces a warbling tone in my basement workroom, where the doorbell transformer is located, when it senses a current surge in the upstairs doorbell wiring. By using a surge in current on the already existing doorbell wiring as the "signal trigger," it saved me from having to run additional signal wires through the walls and ceilings of the house.

### How it works

The complete system schematic is shown in Fig. 1. T1 is the output transformer from an old tube radio. If you don't have an old transformer lying about, you can use anything you can get as long as its windings have approximately the *DC resistance* values shown. (Note. The values are DC resistance, not AC impedance. A transformer having a 2500–5000-ohm primary impedance and a 4–8-ohm secondary impedance will probably provide close to the desired DC resistance values.)

Current flows through T1's low-resistance winding when doorbell BZ1 draws current from bell transformer T2. The current flow through T1 induces a current in T1's high-resistance winding, which forward-biases power-switching transistor Q1 through capacitor C1. That causes collector current flow in Q1, which actuates piezoelectric buzzer BZ2.

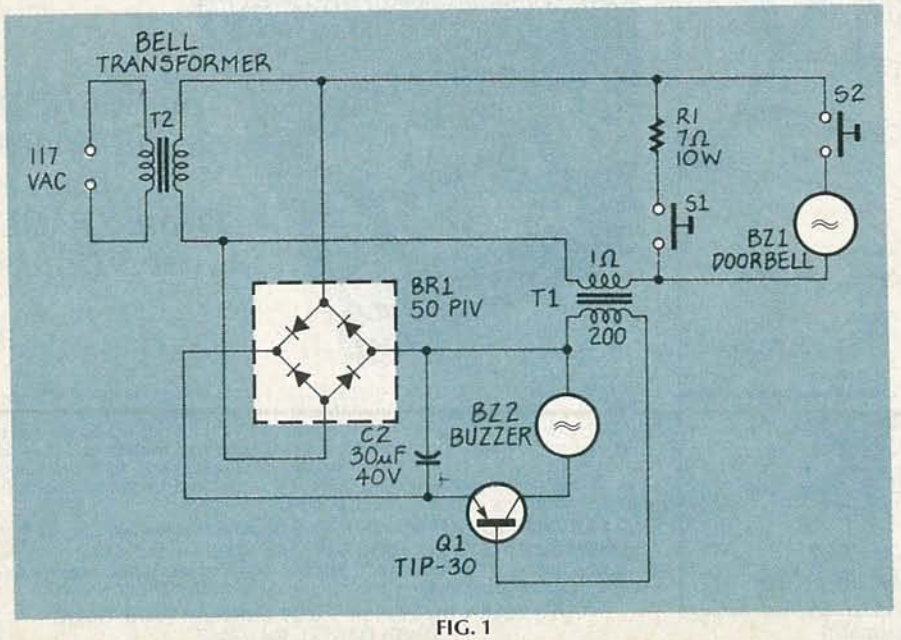


FIG. 1

**NEW IDEAS**

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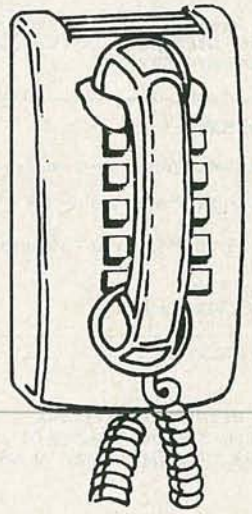

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Power for Q1 and BZ2 is supplied by BR1, a full-wave bridge rectifier that is connected across bell transformer T2. Capacitor C2 functions as a simple filter for the rectifier's output voltage.

If you're not fussy about how the device looks—mine is screwed to a piece of wood nailed with masonry spikes to the wall below my home's bell transformer—you can assemble the signaller on an 8-lug terminal strip. Just be certain to solder all the connections; don't just twist them around the lugs.

### Testing

There should be no sound from buzzer BZ2 when the signaller is connected to the doorbell circuit. If it does make noise, try decreasing the value of C1. My bell transformer puts out 24 volts, others put out between 12 and 30 volts. Capacitor C1 is the variable that's used to compensate for different doorbell voltages. Experimentally increase C1's value for lower voltages, and decrease its value for higher voltages until the circuit works properly. (A false buzzing could also be due to Q1 having excessive leakage.)

To improve the usefulness of the device, I installed a momentary switch (S1) in series with a wirewound resistor (R1) having about the same resistance as the coil of doorbell BZ1 (around 7 ohms), which was located upstairs in the kitchen. When S1 is pressed, a current surge is generated without ringing the doorbell, so the family can easily signal me to pull the "big switch" and close down.

*—John F. Crooks.*

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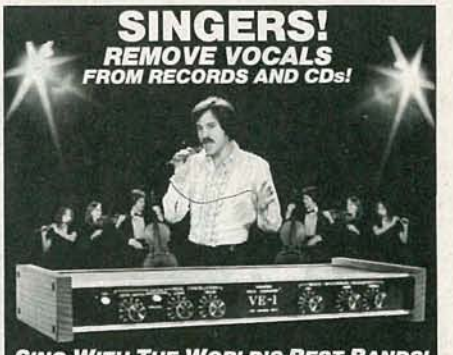

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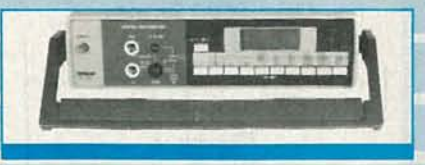

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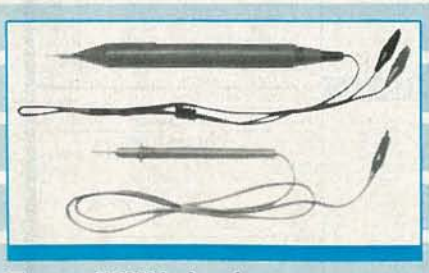

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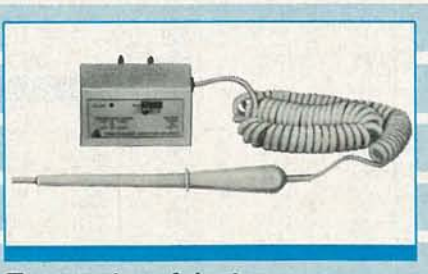

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| 7407 | .27 | 7492 | .50 |
| 7408 | .24 | 7493 | .35 |
| 7409 | .18 | 7494 | .60 |
| 7410 | .18 | 7495 | .55 |
| 7411 | .25 | 7496 | .60 |
| 7412 | .25 | 74107 | .30 |
| 7413 | .35 | 74116 | 1.20 |
| 7414 | .45 | 74121 | .50 |
| 7416 | .25 | 74122 | .45 |
| 7417 | .25 | 74123 | .45 |
| 7420 | .20 | 74125 | .45 |
| 7425 | .27 | 74126 | .45 |
| 7426 | .30 | 74145 | .60 |
| 7427 | .27 | 74148 | 1.20 |
| 7430 | .20 | 74150 | 1.35 |
| 7432 | .27 | 74151 | .55 |
| 7437 | .27 | 74153 | .55 |
| 7438 | .29 | 74154 | 1.25 |
| 7440 | .20 | 74155 | .50 |
| 7442 | .45 | 74156 | .75 |
| 7445 | .65 | 74157 | .55 |
| 7447 | 1.00 | 74158 | .60 |
| 7450 | .20 | 74160 | .85 |
| 7472 | .29 | 74161 | .65 |
| 7473 | .35 | 74162 | .65 |
| 7474 | .32 | 74163 | .65 |
| 7475 | .45 | 74164 | .85 |
| 7476 | .50 | 74165 | .85 |
| | | 74166 | 1.00 |

| 74170 | 1.50 |
|---|---|
| 74173 | .75 |
| 74174 | .85 |
| 74175 | .85 |
| 74176 | .75 |
| 74177 | .65 |
| 74180 | .75 |
| 74181 | 2.00 |
| 74182 | .75 |
| 74184 | 1.50 |
| 74190 | .80 |
| 74191 | .80 |
| 74192 | .75 |
| 74193 | .75 |
| 74194 | .80 |
| 74195 | .80 |
| 74196 | .75 |
| 74197 | .80 |
| 74199 | 1.25 |
| 74221 | 1.25 |
| 74273 | 1.00 |
| 74278 | 1.95 |
| 74279 | .70 |
| 74298 | .60 |
| 74365 | .65 |
| 74367 | .65 |
| 74390 | .90 |
| 75114 | .90 |
| 75115 | .90 |
| 75325 | 1.50 |
| 75491 | 1.00 |
| 9601 | 1.00 |
| 9602 | .90 |
| 8T28 | 1.10 |
| 8T28 | 1.10 |
| 8T97 | 1.10 |
| 8T98 | 1.10 |

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| 200 | .40 | .50 | 1.80 | |
| 400 | .60 | .70 | 2.40 | 9.00 |
| 600 | .80 | 1.00 | 3.60 | 12.00 |

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| LM307 | .45 |
| LM308 | .65 |
| LM311 | .45 |
| LM318 | 1.00 |
| LM319 | 1.10 |
| LM324 | .35 |
| LM339 | .50 |
| LM348 | .65 |
| LF351 | .45 |
| LF353 | .55 |
| LF356 | .35 |
| LF356 | .85 |
| LM358 | .45 |
| LM370 | 1.60 |
| LM380 | .85 |
| LM384 | 1.60 |
| LM386 | .85 |
| LM387 | .95 |
| LM393 | .40 |
| LF398A | 3.00 |
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| LM556 | .45 |
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|---|---|
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| 74C08 | .25 |
| 74C10 | .25 |
| 74C14 | .55 |
| 74C20 | .25 |
| 74C32 | .35 |
| 74C42 | 1.10 |
| 74C74 | .55 |
| 74C76 | .60 |
| 74C85 | 1.25 |
| 74C86 | .35 |
| 74C93 | 1.00 |
| 74C154 | 3.00 |
| 74C157 | .95 |
| 74C161 | .95 |
| 74C174 | .95 |
| 74C175 | .95 |
| 74C193 | 1.25 |
| 74C245 | 1.75 |
| 74C901 | .35 |
| 74C902 | .40 |
| 74C903 | .80 |
| 74C907 | .75 |
| 74C915 | 1.10 |
| 74C921 | 3.50 |
| 4001 | .19 |
| 4002 | .20 |
| 4006 | .65 |
| 4007 | .20 |
| 4008 | .85 |
| 4009 | .35 |
| 4010 | .35 |
| 4011 | .19 |
| 4012 | .25 |
| 4013 | .35 |
| 4014 | .65 |
| 4015 | .28 |
| 4016 | .28 |
| 4017 | .45 |
| 4018 | .65 |
| 4019 | .35 |
| 4020 | .55 |
| 4021 | .65 |
| 4022 | .65 |
| 4023 | .25 |
| 4024 | .48 |
| 4025 | .25 |
| 4026 | 1.25 |
| 4027 | .35 |
| 4028 | .65 |
| 4029 | .65 |
| 4030 | .35 |
| 4034 | 1.40 |
| 4035 | .65 |
| 4040 | .65 |
| 4041 | .75 |
| 4042 | .55 |
| 4043 | .85 |
| 4044 | .65 |
| 4045 | .85 |
| 4046 | .85 |
| 4047 | .65 |
| 4049 | .28 |
| 4050 | .28 |
| 4051 | .65 |
| 4052 | .65 |
| 4053 | .65 |
| 4060 | .65 |
| 4066 | .28 |
| 4068 | .35 |
| 4069 | .19 |
| 4070 | .28 |
| 4071 | .20 |
| 4072 | .20 |
| 4076 | .55 |
| 4077 | .28 |
| 4081 | .20 |
| 4082 | .20 |
| 4093 | .45 |
| 4099 | 1.40 |
| 4501 | .95 |
| 4503 | .45 |
| 4506 | .75 |
| 4510 | .65 |
| 4511 | .65 |
| 4512 | .75 |
| 4514 | .95 |
| 4515 | 1.60 |
| 4516 | .75 |
| 4518 | .85 |
| 4520 | .75 |
| 4528 | .75 |
| 4529 | 1.40 |
| 4538 | .95 |
| 4539 | 1.50 |
| 4541B | 1.20 |
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| 4583 | .90 |
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|---|---|
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| 74C08 | .35 |
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| 74HC11 | .40 |
| 74HC20 | .35 |
| 74HC30 | .35 |
| 74HC32 | .35 |
| 74HC50 | .45 |
| 74HC58 | .50 |
| 74HC74 | .40 |
| 74HC75 | .40 |
| 74HC85 | .70 |
| 74HC107 | .35 |
| 74HC109 | .40 |
| 74HC112 | .40 |

**74HC SERIES**

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|---|---|
| 74HC133 | .60 |
| 74HC137 | .75 |
| 74HC139 | .45 |
| 74HC153 | .55 |
| 74HC154 | 1.75 |
| 74HC157 | .50 |
| 74HC162 | .55 |
| 74HC163 | .55 |
| 74HC164 | .80 |
| 74HC174 | .60 |
| 74HC175 | .60 |
| 74HC194 | .70 |
| 74HC240 | .75 |
| 74HC242 | .75 |
| 74HC244 | .80 |
| 74HC257 | .55 |
| 74HC259 | .60 |
| 74HC273 | .80 |
| 74HC354 | .95 |
| 74HC373 | .80 |
| 74HC374 | .80 |
| 74HC533 | 1.35 |
| 74HC534 | 1.35 |
| 74HC573 | 2.50 |
| 74HC595 | 2.50 |
| 74HC640 | 2.00 |
| 74HC4002 | .50 |
| 74HC4020 | 1.10 |
| 74HC4066 | .60 |
| 74HC4514 | 3.20 |
| 74HC4538 | 1.40 |
| 74HC4543 | 1.40 |

**74LS SERIES**

| 74LS00 | .17 |
|---|---|
| 74LS01 | .17 |
| 74LS02 | .17 |
| 74LS03 | .17 |
| 74LS04 | .17 |
| 74LS05 | .17 |
| 74LS08 | .17 |
| 74LS09 | .17 |
| 74LS10 | .17 |
| 74LS11 | .20 |
| 74LS12 | .27 |
| 74LS13 | .25 |
| 74LS14 | .36 |
| 74LS15 | .25 |
| 74LS20 | .17 |
| 74LS21 | .22 |
| 74LS22 | .22 |
| 74LS26 | .23 |
| 74LS27 | .23 |
| 74LS28 | .26 |
| 74LS30 | .17 |
| 74LS32 | .17 |
| 74LS37 | .26* |
| 74LS38 | .26 |
| 74LS40 | .17 |
| 74LS42 | .35 |
| 74LS48 | .65 |
| 74LS51 | .17 |
| 74LS54 | .22 |
| 74LS73 | .25 |
| 74LS74 | .24 |
| 74LS75 | .29 |
| 74LS76 | .29 |
| 74LS83 | .45 |
| 74LS85 | .45 |
| 74LS86 | .22 |
| 74LS90 | .39 |
| 74LS92 | .45 |
| 74LS93 | .45 |
| 74LS95 | .48 |
| 74LS96 | .49 |
| 74LS97 | .55 |
| 74LS107 | .35 |
| 74LS109 | .35 |
| 74LS112 | .29 |
| 74LS113 | .33 |
| 74LS114 | .33 |
| 74LS123 | .45 |
| 74LS125 | .35 |
| 74LS126 | .35 |
| 74LS132 | .39 |
| 74LS136 | .35 |
| 74LS137 | .90 |
| 74LS138 | .39 |
| 74LS139 | .39 |
| 74LS145 | .70 |
| 74LS147 | 1.00 |
| 74LS148 | .90 |
| 74LS151 | .39 |
| 74LS153 | .39 |
| 74LS154 | 1.50 |
| 74LS155 | .55 |
| 74LS156 | .45 |
| 74LS157 | .35 |
| 74LS158 | .20 |
| 74LS160 | .29 |
| 74LS161 | .49 |
| 74LS162 | .49 |
| 74LS163 | .49 |
| 74LS164 | .45 |
| 74LS165 | .65 |
| 74LS166 | .95 |
| 74LS169 | .90 |
| 74LS170 | .80 |
| 74LS173 | .75 |
| 74LS174 | .39 |
| 74LS175 | .39 |
| 74LS181 | 1.40 |
| 74LS190 | .49 |
| 74LS191 | .49 |
| 74LS192 | .65 |
| 74LS193 | .65 |
| 74LS194 | .65 |
| 74LS195 | .65 |
| 74LS196 | .55 |
| 74LS197 | .55 |
| 74LS221 | .55 |
| 74LS240 | .65 |
| 74LS241 | .65 |
| 74LS242 | .65 |
| 74LS243 | .65 |
| 74LS244 | .65 |
| 74LS245 | .75 |
| 74LS246 | 1.40 |
| 74LS247 | .75 |
| 74LS248 | .65 |
| 74LS251 | .45 |
| 74LS253 | .45 |
| 74LS257 | .39 |
| 74LS258 | .45 |
| 74LS259 | 1.20 |
| 74LS260 | .45 |
| 74LS266 | .55 |
| 74LS273 | .75 |
| 74LS279 | .39 |
| 74LS280 | 1.70 |
| 74LS283 | .55 |
| 74LS290 | .80 |
| 74LS293 | .80 |
| 74LS298 | .65 |
| 74LS299 | 1.25 |
| 74LS320 | 2.00 |
| 74LS322 | 3.00 |
| 74LS323 | 2.40 |
| 74LS365 | .39 |
| 74LS366 | .39 |
| 74LS367 | .39 |
| 74LS368 | .39 |
| 74LS373 | .75 |
| 74LS374 | .75 |
| 74LS377 | .75 |
| 74LS386 | .45 |
| 74LS390 | 1.10 |
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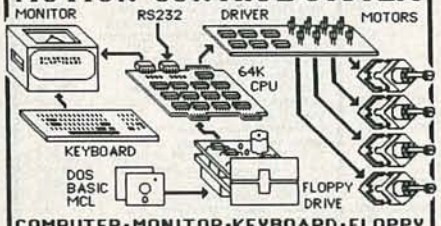


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| 74LS13 | .26 | 74LS145 | .99 | 74LS266 | .39 |
| 74LS14 | .39 | 74LS147 | .99 | 74LS273 | .79 |
| 74LS15 | .26 | 74LS148 | .99 | 74LS279 | .39 |
| 74LS20 | .17 | 74LS151 | .39 | 74LS280 | 1.98 |
| 74LS21 | .22 | 74LS153 | .39 | 74LS283 | .59 |
| 74LS22 | .22 | 74LS154 | 1.49 | 74LS290 | .89 |
| 74LS27 | .23 | 74LS155 | .59 | 74LS293 | .89 |
| 74LS28 | .26 | 74LS156 | .49 | 74LS299 | 1.49 |
| 74LS30 | .17 | 74LS157 | .35 | 74LS322 | 3.95 |
| 74LS32 | .18 | 74LS158 | .29 | 74LS323 | 2.49 |
| 74LS33 | .28 | 74LS160 | .29 | 74LS365 | .39 |
| 74LS37 | .26 | 74LS161 | .39 | 74LS367 | .39 |
| 74LS38 | .26 | 74LS162 | .49 | 74LS368 | .39 |
| 74LS42 | .39 | 74LS163 | .39 | 74LS373 | .79 |
| 74LS47 | .75 | 74LS164 | .49 | 74LS374 | .79 |
| 74LS48 | .85 | 74LS165 | .65 | 74LS375 | .95 |
| 74LS51 | .17 | 74LS166 | .95 | 74LS377 | .79 |
| 74LS73 | .29 | 74LS169 | .95 | 74LS390 | 1.19 |
| 74LS74 | .24 | 74LS173 | .49 | 74LS393 | .79 |
| 74LS75 | .29 | 74LS174 | .39 | 74LS541 | 1.49 |
| 74LS76 | .29 | 74LS175 | .39 | 74LS624 | 1.95 |
| 74LS83 | .49 | 74LS191 | .49 | 74LS640 | .99 |
| 74LS85 | .49 | 74LS192 | .69 | 74LS645 | .99 |
| 74LS86 | .22 | 74LS193 | .69 | 74LS670 | .89 |
| 74LS90 | .39 | 74LS194 | .69 | 74LS682 | 3.20 |
| 74LS92 | .49 | 74LS195 | .69 | 74LS688 | 2.40 |
| 74LS93 | .39 | 74LS196 | .59 | 74LS783 | 22.95 |
| 74LS95 | .49 | 74LS197 | .59 | 25LS2521 | 2.80 |
| 74LS107 | .34 | 74LS221 | .59 | 26LS31 | 1.95 |
| 74LS109 | .36 | 74LS240 | .69 | 26LS32 | 1.95 |

## 7400

| | | | |
|---|---|---|---|
| 7400 | .19 | | |
| 7402 | .19 | | |
| 7404 | .19 | | |
| 7406 | .29 | | |
| 7407 | .29 | | |
| 7408 | .24 | | |
| 7410 | .19 | | |
| 7411 | .25 | | |
| 7414 | .49 | | |
| 7416 | .25 | | |
| 7417 | .25 | | |
| 7420 | .19 | | |
| 7430 | .19 | | |
| 7432 | .29 | | |
| 7438 | .29 | | |
| 7442 | .49 | | |
| 7445 | .69 | | |
| 7447 | .89 | | |
| 7473 | .34 | | |
| 7474 | .33 | | |
| 7475 | .45 | | |
| 7476 | .35 | | |
| 7483 | .50 | | |
| 7485 | .59 | | |
| 7486 | .35 | | |
| 7489 | 2.15 | | |
| 7490 | .39 | | |
| 7493 | .35 | | |
| 74121 | .29 | | |
| 74123 | .49 | | |
| 74125 | .45 | | |
| 74150 | 1.35 | | |
| 74151 | .55 | | |
| 74153 | .55 | | |
| 74154 | 1.49 | | |
| 74157 | .55 | | |
| 74159 | 1.65 | | |
| 74161 | .69 | | |
| 74164 | .85 | | |
| 74166 | 1.00 | | |
| 74175 | .89 | | |
| 74367 | .65 | | |

## LINEAR

| | | | |
|---|---|---|---|
| TL071 | .69 | LM567 | .79 |
| TL072 | 1.09 | NE570 | 2.95 |
| TL074 | 1.95 | NE592 | .98 |
| TL082 | .99 | LM723 | .49 |
| TL084 | 1.49 | LM733 | .98 |
| LM301 | .34 | LM741 | .29 |
| LM309K | 1.25 | LM747 | .69 |
| LM311 | .59 | MC1330 | 1.69 |
| LM311H | .89 | MC1350 | 1.19 |
| LM317K | 3.49 | LM1458 | .35 |
| LM317T | .69 | LM1488 | .49 |
| LM318 | 1.49 | LM1489 | .49 |
| LM319 | 1.25 | LM1496 | .85 |
| LM320 see7900 | | ULN2003 | .79 |
| LM323K | 3.49 | XR2206 | 3.95 |
| LM324 | .34 | XR2211 | 2.95 |
| LM331 | 3.95 | LM2917 | 1.95 |
| LM334 | 1.15 | CA3046 | .89 |
| LM335 | 1.79 | CA3146 | 1.29 |
| LM336 | 1.75 | MC3373 | 1.29 |
| LM338K | 4.49 | MC3470 | 1.95 |
| LM339 | .59 | MC3480 | 8.95 |
| LM340 see7800 | | MC3487 | 2.95 |
| LF353 | .59 | LM3900 | .49 |
| LF356 | .99 | LM3911 | 2.25 |
| LF357 | .99 | LM3909 | .98 |
| LM358 | .59 | LM3914 | 1.89 |
| LM380 | .89 | MC4024 | 3.49 |
| LM383 | 1.95 | MC4044 | 3.99 |
| LM386 | .89 | RC4136 | 1.25 |
| LM393 | .45 | RC4558 | .69 |
| LM394H | 5.95 | LM13600 | 1.49 |
| TL494 | 4.20 | 75107 | 1.49 |
| TL497 | 3.25 | 75110 | 1.95 |
| NE555 | .29 | 75150 | 1.95 |
| NE556 | .49 | 75154 | 1.95 |
| NE558 | .79 | 75188 | 1.25 |
| NE564 | 1.95 | 75189 | 1.25 |
| LM565 | .95 | 75451 | .39 |
| LM566 | 1.49 | 75452 | .39 |
| NE590 | 2.50 | 75477 | 1.29 |

H=TO-5 CAN, K=TO-3, T=TO-220

## 6500

### 1.0 MHz

| | |
|---|---|
| 6502 | 2.25 |
| 65C02 (CMOS) | 7.95 |
| 6520 | 1.65 |
| 6522 | 2.95 |
| 6526 | 13.95 |
| 6532 | 5.95 |
| 6545 | 2.95 |
| 6551 | 2.95 |

### 2.0 MHz

| | |
|---|---|
| 6502A | 2.69 |
| 6520A | 2.95 |
| 6522A | 5.95 |
| 6532A | 11.95 |
| 6545A | 3.95 |
| 6551A | 6.95 |

### 3.0 MHz

| | |
|---|---|
| 6502B | 4.25 |

## Z-80

### 2.5 MHz

| | |
|---|---|
| Z80-CPU | 1.25 |

### 4.0 MHz

| | |
|---|---|
| Z80A-CPU | 1.29 |
| Z80A-CTC | 1.69 |
| Z80A-DART | 5.95 |
| Z80A-DMA | 5.95 |
| Z80A-PIO | 1.89 |
| Z80A-SIO/0 | 5.95 |
| Z80A-SIO/1 | 5.95 |
| Z80A-SIO/2 | 5.95 |

### 6.0 MHz

| | |
|---|---|
| Z80B-CPU | 2.75 |
| Z80B-CTC | 4.25 |
| Z80B-PIO | 4.25 |
| Z80B-DART | 6.95 |
| Z80B-SIO/0 | 12.95 |
| Z80B-SIO/2 | 12.95 |
| Z8671 ZILOG | 9.95 |

## 6800

### 1.0 MHz

| | |
|---|---|
| 6800 | 1.95 |
| 6802 | 2.95 |
| 6803 | 3.95 |
| 6809 | 2.95 |
| 6809E | 2.95 |
| 6810 | 1.95 |
| 6820 | 2.95 |
| 6821 | 1.25 |
| 6840 | 3.95 |
| 6843 | 4.95 |
| 6844 | 6.95 |
| 6845 | 2.75 |
| 6847 | 4.75 |
| 6850 | 1.95 |
| 6883 | 22.95 |

### 2.0 MHz

| | |
|---|---|
| 68B00 | 2.95 |
| 68B02 | 3.95 |
| 68B09E | 5.49 |
| 68B09 | 5.99 |
| 68B21 | 1.85 |
| 68B45 | 4.95 |
| 68B50 | 1.75 |
| 68000 | 9.95 |

## CLOCK CIRCUITS

| | |
|---|---|
| MM58167 | 9.95 |
| MM58174 | 9.95 |
| MSM5832 | 2.95 |

## BIT RATE GENERATORS

| | |
|---|---|
| MC14411 | 9.95 |
| BR1941 | 4.95 |
| 4702 | 9.95 |
| COM8116 | 8.95 |

## INTERSIL

| | |
|---|---|
| ICL7106 | 9.95 |
| ICL7107 | 10.95 |
| ICL7660 | 1.99 |
| ICL8038 | 3.85 |
| ICM7207A | 5.95 |
| ICM7208 | 15.95 |

## DISK CONTROLLERS

| | |
|---|---|
| 1771 | 4.95 |
| 1791 | 9.95 |
| 1793 | 9.95 |
| 1795 | 12.95 |
| 1797 | 12.95 |
| 2791 | 19.95 |
| 2793 | 19.95 |
| 2797 | 29.95 |
| 8272 | 4.39 |
| UPD765 | 4.39 |
| MB8876 | 12.95 |
| MB8877 | 12.95 |
| 1691 | 6.95 |
| 2143 | 6.95 |
| 9216 | 6.29 |

## UARTS

| | |
|---|---|
| AY5-1013 | 3.95 |
| AY3-1015 | 4.95 |
| TR1602 | 3.95 |
| 2651 | 4.95 |
| IM6402 | 3.95 |
| IM6403 | 9.95 |
| INS8250 | 6.95 |
| NS16450 | 10.95 |

## MISC.

| | |
|---|---|
| ADC0804 | 2.99 |
| ADC0809 | 3.85 |
| DAC0800 | 3.29 |
| DAC0808 | 1.95 |
| DAC1022 | 5.95 |
| MC1408L8 | 1.95 |
| 8T28 | 1.29 |
| 8T97 | .59 |
| DP8304 | 2.29 |
| 9334 | 1.75 |
| 9368 | 2.85 |
| 9602 | .69 |
| ULN2003 | .79 |
| MAX232 | 7.95 |
| MC3470 | 1.95 |
| MC3487 | 2.95 |
| AY5-3600 PRO | 11.95 |

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| | |
|---|---|
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| V20* 8 MHz | 10.95 |
| V30 8 MHz | 13.95 |

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| | |
|---|---|
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| 1.0 MHz | 2.95 |
| 1.8432 | 2.95 |
| 2.0 | 1.95 |
| 2.4576 | 1.95 |
| 3.579545 | 1.95 |
| 4.0 | 1.95 |
| 5.0 | 1.95 |
| 5.0688 | 1.95 |
| 6.0 | 1.95 |
| 6.144 | 1.95 |
| 8.0 | 1.95 |
| 10.0 | 1.95 |
| 10.738635 | 1.95 |
| 12.0 | 1.95 |
| 14.31818 | 1.95 |
| 16.0 | 1.95 |
| 18.0 | 1.95 |
| 18.432 | 1.95 |
| 20.0 | 1.95 |
| 22.1184 | 1.95 |
| 24.0 | 1.95 |
| 32.0 | 1.95 |

## OSCILLATORS

| | |
|---|---|
| 1.0MHz | 5.95 |
| 1.8432 | 5.95 |
| 2.0 | 5.95 |
| 2.4576 | 5.95 |
| 2.5 | 5.95 |
| 4.0 | 4.95 |
| 5.0688 | 4.95 |
| 6.0 | 4.95 |
| 6.144 | 4.95 |
| 8.0 | 4.95 |
| 10.0 | 4.95 |
| 12.0 | 4.95 |
| 16.0 | 4.95 |
| 18.432 | 4.95 |
| 20.0 | 4.95 |
| 24.0 | 4.95 |

## PALS

| | |
|---|---|
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| 16R8 | $2.95 |
| 16R6 | $2.95 |
| 16R4 | $2.95 |

## 74F/74S

| | |
|---|---|
| 74F00 | .35 |
| 74F02 | .35 |
| 74F04 | .35 |
| 74F08 | .35 |
| 74F10 | .35 |
| 74F32 | .35 |
| 74F64 | .55 |
| 74F74 | .39 |
| 74F86 | .55 |
| 74F138 | .79 |
| 74F139 | .79 |
| 74F253 | .89 |
| 74F157 | .89 |
| 74F240 | 1.29 |
| 74S00 | .29 |
| 74S02 | .29 |
| 74S04 | .29 |
| 74S08 | .35 |
| 74S10 | .29 |
| 74S32 | .35 |
| 74S74 | .49 |
| 74S86 | .35 |
| 74S112 | .50 |
| 74S124 | 2.75 |
| 74S138 | .79 |
| 74S153 | .79 |
| 74S157 | .79 |
| 74S158 | .95 |
| 74S163 | 1.29 |
| 74S175 | .79 |
| 74S195 | 1.49 |
| 74S240 | 1.49 |
| 74S241 | 1.49 |
| 74S244 | 1.49 |
| 74S280 | 1.95 |
| 74S287 | 1.69 |
| 74S288 | 1.69 |
| 74S299 | 2.95 |
| 74S373 | 1.69 |
| 74S374 | 1.69 |
| 74S471 | 4.95 |
| 74S571 | 2.95 |

## CMOS/HIGH SPEED CMOS

| | | | | | |
|---|---|---|---|---|---|
| 4001 | .19 | 4066 | .29 | 74HC154 | 1.09 |
| 4011 | .19 | 4069 | .19 | 74HC157 | .55 |
| 4012 | .25 | 4070 | .29 | 74HC244 | .85 |
| 4013 | .35 | 4081 | .22 | 74HC245 | .85 |
| 4015 | .29 | 4093 | .49 | 74HC273 | .69 |
| 4016 | .29 | 14411 | 9.95 | 74HC373 | .69 |
| 4017 | .49 | 14433 | 14.95 | 74HC374 | .69 |
| 4018 | .69 | 14497 | 6.95 | 74HCT00 | .25 |
| 4020 | .59 | 4503 | .49 | 74HCT02 | .25 |
| 4021 | .69 | 4511 | .69 | 74HCT04 | .27 |
| 4023 | .25 | 4518 | .85 | 74HCT08 | .25 |
| 4024 | .49 | 4528 | .79 | 74HCT32 | .27 |
| 4025 | .25 | 4538 | .95 | 74HCT74 | .45 |
| 4027 | .39 | 4702 | 9.95 | 74HCT138 | .55 |
| 4028 | .65 | 74HC00 | .21 | 74HCT139 | .55 |
| 4040 | .69 | 74HC02 | .21 | 74HCT161 | .75 |
| 4042 | .59 | 74HC04 | .25 | 74HCT240 | .85 |
| 4044 | .69 | 74HC08 | .25 | 74HCT244 | .85 |
| 4046 | .69 | 74HC10 | .25 | 74HCT245 | .95 |
| 4047 | .69 | 74HC14 | .35 | 74HCT273 | .95 |
| 4049 | .29 | 74HC32 | .35 | 74HCT373 | .95 |
| 4050 | .29 | 74HC74 | .35 | 74HCT374 | .95 |
| 4051 | .69 | 74HC86 | .45 | 74HCT393 | .95 |
| 4052 | .69 | 74HC138 | .45 | 74HCT4017 | 1.15 |
| 4053 | .69 | 74HC139 | .45 | 74HCT4040 | .95 |
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| | | | | | |
|---|---|---|---|---|---|
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| 6.8 | 15V | .42 | 2.2 | 35V | .19 |
| 10 | 15V | .45 | 4.7 | 35V | .39 |
| 22 | 15V | .99 | 10 | 35V | .69 |

### DISC

| | | | | | |
|---|---|---|---|---|---|
| 10pf | 50V | .05 | .001µf | 50V | .05 |
| 22 | 50V | .05 | .005 | 50V | .05 |
| 33 | 50V | .05 | .01 | 50V | .07 |
| 47 | 50V | .05 | .05 | 50V | .07 |
| 100 | 50V | .05 | .1 | 12V | .10 |
| 220 | 50V | .05 | .1 | 50V | .12 |

### MONOLITHIC

| | | | | | |
|---|---|---|---|---|---|
| .01µf | 50V | .14 | .1µf | 50V | .18 |
| .047µf | 50V | .15 | .47µf | 50V | .25 |

### ELECTROLYTIC

| RADIAL | | | AXIAL | | |
|---|---|---|---|---|---|
| 1µf | 25V | .14 | 1µf | 50V | .14 |
| 4.7 | 50V | .11 | 10 | 50V | .16 |
| 10 | 50V | .11 | 22 | 16V | .14 |
| 47 | 35V | .13 | 47 | 50V | .19 |
| 100 | 16V | .15 | 100 | 35V | .19 |
| 220 | 35V | .20 | 470 | 50V | .29 |
| 470 | 25V | .30 | 1000 | 16V | .29 |
| 2200 | 16V | .70 | 2200 | 16V | .70 |
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|---|---|---|---|
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| DIP | 16 PIN | 15 RESISTOR | 1.09 |
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| 7812T | .49 | 7912K | 1.49 |
| 7815T | .49 | 78L05 | .49 |
| 7905T | .59 | 78L12 | .49 |
| 7908T | .59 | 79L05 | .69 |
| 7912T | .59 | 79L12 | 1.49 |
| 7915T | .59 | LM323K | 4.79 |
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| | | | |
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| 1N4004 10/$1.00 | | 4N37 | 1.19 |
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| PN2222 | .10 | 2N3906 | .10 |
| 2N2907 | .25 | 2N4401 | .25 |
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| RIGHT ANGLE SOLDER HEADER | IDHxxSR | .85 | 1.35 | 1.76 | 2.31 | 2.72 | 3.39 |
| WIREWRAP HEADER | IDHxxW | 1.86 | 2.98 | 3.84 | 4.50 | 5.28 | 6.63 |
| RIGHT ANGLE WIREWRAP HEADER | IDHxxWR | 2.05 | 3.28 | 4.22 | 4.45 | 4.80 | 7.30 |
| RIBBON HEADER SOCKET | IDSxx | .63 | .89 | .95 | 1.29 | 1.49 | 1.69 |
| RIBBON HEADER | IDMxx | --- | 5.50 | 6.25 | 7.00 | 7.50 | 8.50 |
| RIBBON EDGE CARD | IDExx | .85 | 1.25 | 1.35 | 1.75 | 2.05 | 2.45 |
| 10' GREY RIBBON CABLE | RCxx | 1.60 | 3.20 | 4.10 | 5.40 | 6.40 | 7.50 |

*FOR ORDERING INSTRUCTIONS, SEE D-SUBMINIATURE CONNECTORS, BELOW*

## SPECTRONICS CORPORATION EPROM ERASERS

| Model | Timer | Chip Capacity | Intensity (uW/Cm²) | Unit Cost |
|---|---|---|---|---|
| PE-140 | NO | 9 | 8,000 | $89 |
| PE-140T | YES | 9 | 8,000 | $139 |
| PE-240T | YES | 12 | 9,600 | $189 |

## SWITCHES

| | | |
|---|---|---|
| SPDT | MINI-TOGGLE ON-ON | 1.25 |
| DPDT | MINI-TOGGLE ON-ON | 1.50 |
| DPDT | MINI-TOGGLE ON-OFF-ON | 1.75 |
| SPST | MINI-PUSHBUTTON N.O. | .39 |

## DIP SWITCHES

| | | | |
|---|---|---|---|
| 4 position | .85 | 7 position | .95 |
| 5 position | .90 | 8 position | .95 |
| 6 position | .90 | 10 position | 1.29 |

## LIGHT EMITTING DIODES

## LED DISPLAYS

| | | | |
|---|---|---|---|
| FND-357(359) | COM CATHODE | .362" | 1.25 |
| FND-500(503) | COM CATHODE | .5" | 1.49 |
| FND-507(510) | COM ANODE | .5" | 1.49 |
| MAN-72 | COM ANODE | .3" | .99 |
| MAN-74 | COM CATHODE | .3" | .99 |
| TIL-313 | COM CATHODE | .3" | .45 |
| TIL-311 | 4x7 HEX W/LOGIC | .270" | 10.95 |

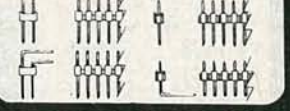
## DIFFUSED LEDs

| | | 1-99 | 100-UP |
|---|---|---|---|
| JUMBO RED | T1¾ | .10 | .09 |
| JUMBO GREEN | T1¾ | .14 | .12 |
| JUMBO YELLOW | T1¾ | .14 | .12 |
| MOUNTING HDW | T1¾ | .10 | .09 |
| MINI RED | T1 | .10 | .09 |

## "SNAPABLE" HEADERS

CAN BE SNAPPED APART TO MAKE ANY SIZE HEADER, ALL WITH .1" CENTERS

| | | |
|---|---|---|
| 1x40 | STRAIGHT LEAD | .99 |
| 1x40 | RIGHT ANGLE LEAD | 1.49 |
| 2x40 | 2 STRAIGHT LEADS | 2.49 |
| 2x40 | 2 RIGHT ANGLE LEADS | 2.99 |



## D-SUBMINIATURE CONNECTORS

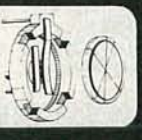
| DESCRIPTION | | ORDER BY | CONTACTS 9 | 15 | 19 | 25 | 37 | 50 |
|---|---|---|---|---|---|---|---|---|
| SOLDER CUP | MALE | DBxxP | .45 | .59 | .69 | .69 | 1.35 | 1.85 |
| | FEMALE | DBxxS | .49 | .69 | .75 | .75 | 1.39 | 2.29 |
| RIGHT ANGLE PC SOLDER | MALE | DBxxPR | .49 | .69 | --- | .79 | 2.27 | --- |
| | FEMALE | DBxxSR | .55 | .75 | --- | .85 | 2.49 | --- |
| WIREWRAP | MALE | DBxxPWW | 1.69 | 2.56 | --- | 3.89 | 5.60 | --- |
| | FEMALE | DBxxSWW | 2.76 | 4.27 | --- | 6.84 | 9.95 | --- |
| IDC RIBBON CABLE | MALE | IDBxxP | 1.39 | 1.99 | --- | 2.25 | 4.25 | --- |
| | FEMALE | IDBxxS | 1.45 | 2.05 | --- | 2.35 | 4.49 | --- |
| HOODS | METAL | MHOODxx | 1.05 | 1.15 | 1.25 | 1.25 | --- | --- |
| | GREY | HOODxx | .39 | .39 | --- | .39 | .69 | .75 |

*ORDERING INSTRUCTIONS:*
*INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED. EXAMPLE: A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR.*

**MOUNTING HARDWARE 59¢**

## 3 VOLT LITHIUM BATTERY $1.95

**HOLDER $1.49**



## 25 PIN D-SUB GENDER CHANGERS $7.95

## IC SOCKETS/DIP CONNECTORS

| DESCRIPTION | ORDER BY | CONTACTS 8 | 14 | 16 | 18 | 20 | 22 | 24 | 28 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|
| SOLDERTAIL SOCKETS | xxST | .11 | .11 | .12 | .15 | .18 | .15 | .20 | .22 | .30 |
| WIREWRAP SOCKETS | xxWW | .59 | .69 | .69 | .99 | 1.09 | 1.39 | 1.49 | 1.69 | 1.99 |
| ZIF SOCKETS | ZIFxx | --- | 4.95 | 4.95 | --- | 5.95 | --- | 5.95 | 6.95 | 9.95 |
| TOOLED SOCKETS | AUGATxxST | .62 | .79 | .89 | 1.09 | 1.29 | 1.39 | 1.49 | 1.69 | 2.49 |
| TOOLED WW SOCKETS | AUGATxxWW | 1.30 | 1.80 | 2.10 | 2.40 | 2.50 | 2.90 | 3.15 | 3.70 | 5.40 |
| COMPONENT CARRIERS | ICCxx | .49 | .59 | .69 | .99 | .99 | .99 | .99 | 1.09 | 1.49 |
| DIP PLUGS (IDC) | IDPxx | .95 | .49 | .59 | 1.29 | 1.49 | --- | .85 | 1.49 | 1.59 |

*FOR ORDERING INSTRUCTIONS, SEE D-SUBMINIATURE CONNECTORS, ABOVE*

I would like you to know that I think you have a special employee in Helen M ...giving the usual courteous and competent service that I have come to expect from JDR. Keep up the good work.

John Medcalf

## EMI FILTER $4.95

## LINE CORDS

2 conductor 39¢ 3 conductor 99¢
3 conductor w/female socket $1.49

**CALL FOR VOLUME QUOTES**

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CIRCLE 176 ON FREE INFORMATION CARD

# 64K DRAM 4164 150ns $1.29

# 256K DRAM 41256 150ns $2.95

## MONITOR STANDS

**MODEL MS-100** $12.95

- TILTS & SWIVELS
- STURDY PLASTIC CONSTRUCTION

**MODEL MS-200** $39.95

- TILTS AND SWIVELS
- BUILT-IN SURGE SUPRESSOR
- BUILT-IN POWER STATION INDEPENDENTLY CONTROLS UP TO 5 120 VOLT AC OUTLETS
- UL APPROVED

## NASHUA DISKETTES

BOXES OF 10

| | | |
|---|---|---|
| 5¼" | DS/DD 360K | $9.95 |
| 5¼" | DS/HD 1.2M | $24.95 |
| 3½" | DS/QD 720K | $16.95 |

5¼" DS/DD SOFT SECTOR

49¢ea BULK QTY 50

39¢ea BULK QTY 250

## 5¼" DISKETTE STORAGE FILE $8.95

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- STURDY, ATTRACTIVE SMOKED ACRYLIC CASE
- COMPLETE WITH HINGED DIVIDERS

VERSION FOR 3½" FLOPPIES AVAILABLE $9.95

## 2 WAY SWITCH BOXES $39.95

- CONNECT 2 PRINTERS TO 1 COMPUTER OR VICE VERSA
- SERIAL & PARALLEL MODELS AVAILABLE
- ALL LINES SWITCHED
- GOLD PLATED CONNECTORS & QUALITY SWITCHES

## 6' INTERFACE CABLES

*MEETS FCC REQUIREMENTS 100% SHIELDED*

| | |
|---|---|
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| CENTRONICS (MALE TO FEMALE) | $15.95 |
| CENTRONICS (MALE TO MALE) | $14.95 |
| IBM COMPATIBLE MODEM CABLE | $7.95 |
| RS232 SERIAL (MALE TO FEMALE) | $9.95 |
| RS232 SERIAL (MALE TO MALE) | $9.95 |
| COILED KEYBOARD EXTENDER | $7.95 |

## JOYSTICK $19.95

- SET X-Y AXIS FOR AUTO CENTER OR FREE MOVEMENT
- FIRE BUTTON FOR USE WITH GAME SOFTWARE
- INCLUDES ADAPTOR CABLE FOR IBM

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**PS-135** $59.95

- FOR IBM XT COMPATIBLE
- UL APP., 135 WATTS
- +5V/15A, -12V/4.2A -5V/.5A, -12V/.5A
- ONE YEAR WARRANTY

**PS-150** *150W MODEL* $69.95

PS-135/150

**PS-200** $89.95

- FOR IBM AT COMPATIBLE
- 200 WATTS
- +5V/22A, +12V/8A -5V/.5A, -12V/.5A
- ONE YEAR WARRANTY

PS-200

**PS-A** $49.95

- FOR APPLE TYPE SYSTEM
- +5V/6A, +12V/3A -5V/1A, -12V/1A
- APPLE CONNECTOR

**PS-1558** $34.95

- 75 WATTS, UL APPROVED
- BY POWER SYSTEMS
- +5V/7A, +12V/3A -12V/250mA, -5/300mA

PS-1558

## MONITORS

### SAMSUNG MONOCHROME

- IBM COMPATIBLE TTL INPUT
- 12" NON-GLARE, LOW DISTORTION, AMBER SCREEN
- RES: 720 x 350
- SWIVEL BASE
- 1 YEAR WARRANTY

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### MULTISYNC *BY NEC* $549.95

- ORIGINAL CGA/EGA/PGA COMPATIBLE MONITOR
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- RESOLUTION AS HIGH AS 800 x 560

### EGA *BY CASPER* $399.95

- 15.75/21.85 KHz SCANNING FREQUENCIES
- RES: 640 x 200/350
- .31mm DOT PITCH
- 14" BLACK MATRIX SCREEN
- 16 COLORS FROM 64

### RGB *BY CASPER* $279.95

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- RGB/IBM COMPATIBLE
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- .39mm DOT PITCH
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### MONOCHROME *BY HYUNDAI* $69.95

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- ATTRACTIVE CASING WITH A TILT/SWIVEL BASE

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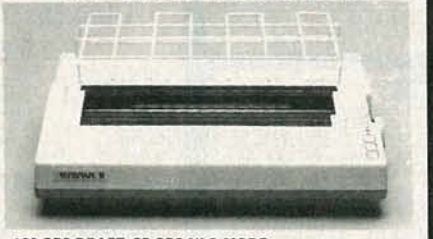
## 20MB HARD DISK ON A CARD

- SAVES SPACE AND REDUCES POWER CONSUMPTION
- IDEAL FOR PCs WITH FULL HEIGHT FLOPPIES
- LEAVES ROOM FOR A HALF LENGTH CARD IN ADJACENT SLOT

$349

## RITEMAN II PRINTER



- 160 CPS DRAFT, 32 CPS NLQ MODE
- SUPPORTS EPSON/IBM GRAPHICS
- 9 x 9 DOT MATRIX
- FRICTION AND PIN FEEDS
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IBM COMPATIBLE PRINTER CABLE $9.95

REPLACEMENT RIBBON CARTRIDGE $7.95

## DISK DRIVES

### 5¼" SEAGATE HARD DISK DRIVES

| | | |
|---|---|---|
| ST-225 | HALF HEIGHT 20MB 65ms | $259 |
| ST-238 | HALF HEIGHT 30MB 65ms (RLL) | $299 |
| ST-251 | HALF HEIGHT 40MB 40ms | $469 |
| ST-277 | HALF HEIGHT 60MB 40ms (RLL) | $649 |
| ST-4038 | FULL HEIGHT 30MB 40ms | $559 |
| ST-4096 | FULL HEIGHT 80MB 28ms | $895 |

### ½ HEIGHT FLOPPY DISK DRIVES

| | |
|---|---|
| 5¼" TEAC FD-55B DS/DD 360K | $99.95 |
| 5¼" TEAC FD-55F DS/QUAD 720K | $119.95 |
| 5¼" TEAC FD-55G DS/HD 1.2M | $129.95 |
| 5¼" FUJITSU M2551A DS DD 360K | $89.95 |
| 5¼" FUJITSU M2553K DS HD 1.2M | $119.95 |
| 5¼" DS/DD 360K | $69.95 |
| 5¼" DS/HD 1.2M | $109.95 |
| 3½" MITSUBISHI DS/DD (AT OR XT) | $129.95 |

### DISK DRIVE ACCESSORIES

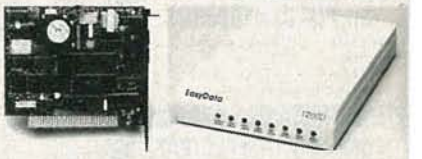
| | |
|---|---|
| ½ HT MOUNTING HARDWARE FOR IBM | $2.95 |
| MOUNTING RAILS FOR IBM AT | $4.95 |
| "Y" POWER CABLE FOR 5¼" FDDs | $2.95 |
| 5¼" FDD POWER CONNECTORS | $1.19 |

### DRIVE ENCLOSURES WITH POWER SUPPLIES

| | | |
|---|---|---|
| CAB-2SV5 | DUAL SLIMLINE FOR 5¼" | $49.95 |
| CAB-1FH5 | FULL HEIGHT FOR 5¼" | $69.95 |
| CAB-2SV8 | DUAL SLIMLINE FOR 8" | $209.95 |
| CAB-2FH8 | DUAL FULL HEIGHT FOR 8" | $219.95 |

## EASYDATA MODEMS

*All models feature auto-dial/answer/redial on busy, power up self test, touchtone or pulse dialing, built-in speaker, Hayes and Bell Systems 103 & 212A compatible, full or half duplex, PC Talk III Communications software with internal models and more.*



### INTERNAL

| | | |
|---|---|---|
| 12H | 1200 BAUD ½ CARD | $69.95 |
| 24B | 2400 BAUD FULL CARD | $179.95 |

### EXTERNAL

*(NO SOFTWARE INCLUDED)*

| | | |
|---|---|---|
| 12D | 1200 BAUD | $119.95 |
| 24D | 2400 BAUD | $219.95 |

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- FRONT PANEL KEYLOCK AND LED INDICATORS

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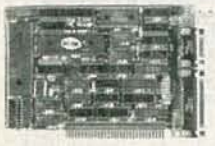
CIRCLE 177 ON FREE INFORMATION CARD

# ALL MCT PRODUCTS CARRY A 1 YEAR WARRANTY

## INTERFACE CARDS

*FROM MODULAR CIRCUIT TECHNOLOGY*



RUNS COLOR SOFTWARE

MCT-MGP

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**MCT-MGP** MONOCHROME GRAPHICS **$59.95**
*TRUE HERCULES COMPATIBILITY, SUPPORTS LOTUS 123*
- SOFTWARE DRIVER ALLOWS COLOR GRAPHICS PROGRAMS TO RUN ON A MONOCHROME MONITOR
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*100% IBM COMPATIBLE, PASSES IBM EGA DIAGNOSTICS*
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- COMPATIBLE WITH COLOR AND MONOCHROME ADAPTORS

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- 640/320 x 200 RESOLUTION, LIGHT PEN INTERFACE

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*ALL THE FEATURES OF 6 PACK - AT HALF THE PRICE*
- 0-384K DYNAMIC RAM USING 4164s
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*TOTAL SYSTEM CONTROL FROM A SINGLE SLOT*
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- RUN COLOR GRAPHICS SOFTWARE ON A MONOCHROME MONITOR

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*A PERFECT COMPANION FOR OUR MOTHERBOARDS*
- SERIAL, PARALLEL, GAME PORT, CLOCK/CALENDAR
- SUPPORTS UP TO 2 360K FLOPPIES, 720K WITH DOS 3.2

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*USE WITH MCT-FH FOR A MINIMUM OF SLOTS USED*
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- PARALLEL PRINTER PORT ADDRESSABLE AS LPT1 OR LPT2

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*ADDS UP TO 3 MEGABYTES OF RAM TO THE AT*
- USER EXPANDABLE TO 1.5 MB OF MEMORY (ZERO K INSTALLED)
- INCLUDES SERIAL PORT AND PARALLEL PORT

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*USE WITH MCT-ATFH FOR A MINIMUM OF SLOTS USED*
- SERIAL, PARALLEL AND GAME PORTS
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*A CONTIGUOUS MEMORY SOLUTION IN A SHORT SLOT*
- USER SELECTABLE CONFIGURATION AMOUNTS UP TO 576K USING 64K & 256K RAM CHIPS (ZERO K INSTALLED)

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*2 MB OF LOTUS INTEL MICROSOFT COMPATIBLE MEMORY FOR XT*
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- USER EXPANDABLE TO 2 MB
- EXPANDED/CONVENTIONAL MEMORY, RAMDISK AND SPOOLER

MCT-ATEMS AT VERSION $139.95

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**MCT-FDC** FLOPPY DISK CONTROLLER **$29.95**
*QUALITY DESIGN OFFERS 4 FLOPPY CONTROL IN A SINGLE SLOT*
- INTERFACES UP TO 4 FDDs TO AN IBM PC OR COMPATIBLE
- SUPPORTS BOTH DS/DD AND DS/QD WITH DOS 3.2

**MCT-HDC** HARD DISK CONTROLLER **$79.95**
*HD CONTROL FOR WHAT OTHERS CHARGE FOR FLOPPY CONTROL*
- SUPPORTS 16 DRIVE SIZES INCLUDING 5, 10, 20, 30 & 40 MB
- DIVIDE 1 LARGE DRIVE INTO 2 SMALLER, LOGICAL DRIVES

**MCT-FDC-1.2** 1.2MB FLOPPY CONTROLLER **$69.95**
*ADD VERSATILITY & CAPACITY TO YOUR XT*
- SUPPORTS 2 DRIVES, BOTH MAY BE 360K OR 1.2 MEG
- ALLOWS DATA TO FLOW FREELY FROM XTs TO ATs

**MCT-FH** FLOPPY/HARD CONTROLLER **$139.95**
*SYSTEM STARVED FOR SLOTS? SATISFY IT WITH THIS TIMELY DESIGN*
- INTERFACES UP TO 2 FDDs & 2 HDDs, CABLING FOR 2 FDDs & 1 HDD
- SUPPORTS BOTH DS DD & DS QD WITH DOS 3.2

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*FLOPPY/HARD DISK CONTROL IN A TRUE AT DESIGN*
- SUPPORTS UP TO 2 360K/720K/1.2MB FDDs AS WELL AS 2 HDDs USING STANDARD CONTROL TABLES

## Seagate

### ½ HEIGHT HARD DISK DRIVES

**40 MB $469**
**60 MB $649**

*Drives are Seagate models ST-251 (40 MB) & ST-277 (60 MB RLL) 5¼" half heights FAST 40ms access time!*

### ½ HT HARD DISK SYSTEMS

**20 MB $289**
**30 MB $329**

*Systems include Seagate ½ height hard drive, drive controller, cables & instructions. All drives are pre-tested & warranted for 1 year.*

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*FROM MODULAR CIRCUIT TECHNOLOGY*

**MCT-TURBO** TURBO 4.77/8 MHz **$99.95**
- 4.77 OR 8 MHz OPERATION WITH 8088-2 & OPTIONAL 8087-2 CO-PROCESSOR
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- 8 SLOT (2 EIGHT BIT, 6 SIXTEEN BIT) AT MOTHERBOARD
- HARDWARE SELECTION OF 6 OR 8 MHz
- 1 WAIT STATE
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- SOCKETS FOR 1 MB OF RAM AND 80287
- BATTERY BACKED CLOCK

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- BATTERY BACKED CLOCK
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*FULL ONE YEAR WARRANTY*

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- IBM ENHANCED STYLE LAYOUT
- SOFTWARE AUTOSENSE FOR XT OR AT COMPATIBLES
- LED INDICATORS
- AUTO REPEAT FEATURE
- SEPARATE CURSOR PAD

**MCT-5060** **$59.95**
- IBM AT STYLE LAYOUT
- SOFTWARE AUTOSENSE FOR XT OR AT COMPATIBLES
- LED INDICATORS
- AUTO REPEAT FEATURE

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## WHY BUY A SYSTEM FROM JDR?

- BUILD IT YOURSELF AND SAVE!
- MONEY BACK GUARANTEE (ASK FOR DETAILS)
- LEARN ABOUT THE INNER WORKINGS OF A COMPUTER
- YOU CAN ASSEMBLE A SYSTEM IN ABOUT 2 HOURS WITH A SCREWDRIVER & OUR EASY-TO-FOLLOW INSTRUCTIONS
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- ★ 256K OF MEMORY
- ★ 135 WATT POWER SUPPLY
- ★ FLIP-TOP CASE
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- ★ 360K FLOPPY DRIVE
- ★ DRIVE CONTROLLER
- ★ MONOCHROME MONITOR
- ★ GRAPHICS ADAPTOR

**FOR ONLY $489.15**

ANYONE CAN BUILD A SYSTEM IN ABOUT 2 HOURS USING A SCREWDRIVER AND OUR EASY-TO-FOLLOW INSTRUCTIONS!

## DEVELOPMENT TOOLS

*FROM MODULAR CIRCUIT TECHNOLOGY*

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## INTEGRATED CIRCUITS

### 7400 TTL

| Part | Price |
|---|---|
| 7400N | .48 |
| 7401N | .48 |
| 7402N | .48 |
| 7403N | .48 |
| 7404N | .50 |
| 7405N | .53 |
| 7406N | .75 |
| 7407N | .75 |
| 7408N | .50 |
| 7409N | .50 |
| 7410N | .48 |
| 7411N | .60 |
| 7413N | .60 |
| 7414N | .68 |
| 7416N | .68 |
| 7417N | .58 |
| 7420N | .48 |
| 7423N | .68 |
| 7425N | .53 |
| 7426N | .53 |
| 7427N | .53 |
| 7430N | .48 |
| 7432N | .48 |
| 7437N | .58 |
| 7438N | .58 |
| 7440N | .55 |
| 7441AN | .75 |
| 7442N | .68 |
| 7445N | 1.18 |
| 7446N | 1.25 |
| 7447N | 1.25 |
| 7450N | .53 |
| 7451N | .48 |
| 7453N | .59 |
| 7454N | .53 |
| 7455N | .25 |
| 7460N | .35 |
| 7470N | .60 |
| 7472N | .53 |
| 7473N | .58 |
| 7474N | .58 |
| 7475N | .72 |
| 7476N | .59 |
| 7483N | .63 |
| 7485N | .99 |
| 7486N | .60 |
| 7489N | 3.75 |
| 7490N | .60 |
| 7491N | .63 |
| 7492N | .70 |
| 7493N | .70 |
| 7496N | .70 |
| 74100N | .83 |
| 74107N | .63 |
| 74109N | .63 |
| 74121N | .60 |
| 74123N | .80 |
| 74125N | .76 |
| 74132N | .63 |
| 74141N | 1.63 |
| 74145N | 1.10 |
| 74147N | 3.36 |
| 74150N | 2.03 |
| 74151N | .73 |
| 74153N | .73 |
| 74154N | 1.50 |
| 74156N | .73 |
| 74157N | .76 |
| 74160N | .98 |
| 74161N | .98 |
| 74163N | .98 |
| 74164N | .98 |
| 74165N | 1.25 |
| 74166N | .98 |
| 74169N | 2.63 |
| 74173N | 1.38 |
| 74174N | .88 |
| 74175N | .88 |
| 74176N | 1.20 |
| 74177N | 1.20 |
| 74180N | 1.13 |
| 74181N | 3.00 |
| 74182N | 1.15 |
| 74184N | 2.63 |
| 74185N | 2.63 |
| 74190N | 1.06 |
| 74191N | 1.06 |
| 74192N | 1.28 |
| 74193N | 1.06 |
| 74194N | 1.06 |
| 74195N | .75 |
| 74197N | 1.20 |
| 74198N | 1.88 |
| 74199N | 1.88 |
| 74251N | 1.25 |
| 74265N | .83 |
| 74273N | .83 |
| 74279N | .83 |
| 74283N | 1.50 |
| 74284N | 3.75 |
| 74285N | 3.75 |
| 74365N | 1.25 |
| 74366N | 1.25 |
| 74367N | 1.25 |
| 74368N | 1.25 |
| 74373N | 1.25 |
| 74374N | 1.25 |
| 74377N | 1.25 |
| 74378N | 1.25 |
| 74379N | 1.25 |
| 74390N | 1.75 |
| 74393N | 1.75 |
| 74399N | 3.75 |
| 74490N | 1.75 |
| 74670N | 2.63 |
| 74LS00N | .45 |
| 74LS01N | .50 |
| 74LS02N | .45 |
| 74LS03N | .45 |
| 74LS04N | .45 |
| 74LS05N | .48 |
| 74LS08N | .48 |
| 74LS09N | .48 |
| 74LS10N | .45 |
| 74LS11N | .45 |
| 74LS12N | .45 |
| 74LS13N | .80 |
| 74LS14N | .80 |
| 74LS15N | .45 |
| 74LS20N | .45 |
| 74LS21N | .45 |
| 74LS22N | .45 |
| 74LS26N | .45 |
| 74LS27N | .45 |
| 74LS28N | .45 |
| 74LS30N | .45 |
| 74LS32N | .45 |
| 74LS33N | .53 |
| 74LS38N | .50 |
| 74LS42N | .75 |
| 74LS48N | 1.38 |
| 74LS49N | 1.10 |
| 74LS51N | .45 |
| 74LS54N | .45 |
| 74LS55N | .45 |
| 74LS73AN | .53 |
| 74LS74AN | .53 |
| 74LS75N | .68 |
| 74LS76AN | .53 |
| 74LS83AN | .98 |
| 74LS85N | .98 |
| 74LS86AN | .53 |
| 74LS90N | .68 |
| 74LS92N | .68 |
| 74LS93N | 1.50 |
| 74LS95BN | 1.25 |
| 74LS96N | 1.38 |
| 74LS107AN | .53 |
| 74LS109AN | .53 |
| 74LS112AN | .53 |
| 74LS113N | 1.13 |
| 74LS114AN | .58 |
| 74LS122N | .75 |
| 74LS123N | 1.13 |
| 74LS125AN | .68 |
| 74LS126N | .68 |
| 74LS132N | 1.03 |
| 74LS136N | .83 |
| 74LS138N | .83 |
| 74LS139N | .83 |
| 74LS145N | 1.50 |
| 74LS147N | 1.75 |
| 74LS148N | 1.75 |
| 74LS151N | .83 |
| 74LS153N | .83 |
| 74LS154N | 1.50 |
| 74LS155AN | .83 |
| 74LS156N | .83 |
| 74LS157AN | .83 |
| 74LS158N | .83 |
| 74LS160AN | .98 |
| 74LS161AN | .98 |
| 74LS162AN | .98 |
| 74LS163AN | .98 |
| 74LS164N | 1.05 |
| 74LS165AN | 1.25 |
| 74LS166N | 1.75 |
| 74LS169AN | 1.75 |
| 74LS170N | 2.63 |
| 74LS173AN | 1.25 |
| 74LS174N | 1.05 |
| 74LS175AN | 1.05 |
| 74LS181N | 3.00 |
| 74LS190N | 1.13 |
| 74LS191N | 1.13 |
| 74LS193N | 1.08 |
| 74LS195AN | .98 |
| 74LS221N | 1.45 |
| 74LS240N | 1.45 |
| 74LS241N | 1.45 |
| 74LS243N | 1.45 |
| 74LS244N | 1.50 |
| 74LS245N | 1.50 |
| 74LS251N | .78 |
| 74LS253N | .78 |
| 74LS257N | .78 |
| 74LS258N | .78 |
| 74LS259N | 1.50 |
| 74LS260N | 1.00 |
| 74LS273N | .78 |
| 74LS280N | 1.75 |
| 74LS290N | 1.00 |
| 74LS293N | .78 |
| 74LS295N | 1.50 |
| 74LS298N | 1.50 |
| 74LS299N | 3.00 |
| 74LS322AN | 3.00 |
| 74LS323N | 3.00 |
| 74LS347N | 1.75 |
| 74LS352N | 1.00 |
| 74LS353N | 1.00 |
| 74LS365AN | .68 |
| 74LS366AN | .68 |
| 74LS367AN | .68 |
| 74LS368AN | .68 |
| 74LS373N | .78 |
| 74LS374N | .78 |
| 74LS375N | .78 |
| 74LS377N | .98 |
| 74LS378N | 1.25 |
| 74LS379N | 1.25 |
| 74LS386N | 1.13 |
| 74LS390N | 1.10 |
| 74LS393N | 1.10 |
| 74LS395AN | 1.25 |
| 74LS396N | 1.75 |
| 74LS398N | 1.75 |
| 74LS399N | 1.75 |
| 74LS424N | 1.75 |
| 74LS447AN | 1.25 |
| 74LS490N | 2.63 |
| 74LS670N | 2.63 |
| 74LS682N | 3.75 |
| 74LS683N | 3.75 |
| 74LS684N | 3.75 |
| 74LS685N | 3.75 |
| 74LS686N | 3.75 |
| 74LS687N | 3.75 |
| 74LS688N | 3.75 |
| 74LS689N | 3.75 |
| 74LS690N | 2.63 |
| 74LS691N | 3.75 |
| 74LS692N | 3.75 |
| 74LS693N | 3.75 |
| 74LS696N | 4.50 |
| 74LS697N | 4.50 |
| 74LS698N | 4.50 |
| 74LS699N | 4.50 |
| 74LS783N | 2.63 |
| 74LS784N | 2.63 |
| 74LS785N | 2.63 |
| 74LS786N | 2.63 |
| 74LS787N | 2.63 |
| 74LS788N | 2.63 |
| 74LS789N | 2.63 |
| 74LS790N | 2.63 |
| 74LS791N | 2.63 |
| 74LS792N | 2.63 |
| 74LS793N | 2.63 |
| 74LS794N | 2.63 |
| 74LS795N | 2.63 |
| 74LS796N | 2.63 |
| 74LS797N | 2.63 |
| 74LS798N | 2.63 |
| 74LS799N | 2.63 |

### 74S00 TTL

| Part | Price |
|---|---|
| 74S00N | .60 |
| 74S01N | .63 |
| 74S02N | .60 |
| 74S03N | .70 |
| 74S04N | .70 |
| 74S05N | .70 |
| 74S08N | .70 |
| 74S09N | .70 |
| 74S10N | .60 |
| 74S11N | .60 |
| 74S112N | .75 |
| 74S113N | .75 |
| 74S114N | .75 |
| 74S124N | 2.25 |
| 74S132N | 1.25 |
| 74S133N | .60 |
| 74S134N | 1.25 |
| 74S135N | 1.25 |
| 74S138N | .75 |
| 74S139N | .75 |
| 74S140N | 1.25 |
| 74S151N | .75 |
| 74S153N | .75 |
| 74S157N | .75 |
| 74S158N | .75 |
| 74S161N | 3.75 |
| 74S162N | 2.88 |
| 74S163N | 2.88 |
| 74S174N | 1.75 |
| 74S175N | 1.75 |
| 74S181N | 5.50 |
| 74S182N | 2.25 |
| 74S188N | 3.75 |
| 74S189N | 2.25 |
| 74S194N | 2.25 |
| 74S195N | 2.25 |
| 74S196N | 3.75 |
| 74S197N | 3.75 |
| 74S240N | 2.88 |
| 74S241N | 2.88 |
| 74S244N | 2.88 |
| 74S253N | 1.63 |
| 74S257N | 1.50 |
| 74S258N | 1.50 |
| 74S260N | 2.63 |
| 74S280N | 3.00 |
| 74S288N | 2.25 |
| 74S373N | 2.63 |
| 74S374N | 2.63 |
| 74S471N | 4.88 |
| 74S472N | 7.88 |
| 74S473N | 7.88 |
| 74S474N | 4.88 |
| 74S570N | 4.38 |
| 74S571N | 4.88 |
| 74S572N | 7.88 |
| 74S573N | 7.88 |
| 74S574N | 4.88 |
| 74S941N | 3.50 |

### 74HC00 CMOS

| Part | Price |
|---|---|
| 74HC00N | .68 |
| 74HC02N | .68 |
| 74HC04N | .68 |
| 74HC08N | .68 |
| 74HC10N | .68 |
| 74HC11N | .68 |
| 74HC14N | .68 |
| 74HC20N | .68 |
| 74HC30N | .68 |
| 74HC32N | .68 |
| 74HC73N | .68 |
| 74HC74N | .68 |
| 74HC86N | .68 |
| 74HC107N | .68 |
| 74HC112N | .68 |
| 74HC123N | 2.70 |
| 74HC125N | .68 |
| 74HC126N | 2.05 |
| 74HC133N | .68 |
| 74HC138N | .68 |
| 74HC139N | 1.23 |
| 74HC147N | 1.75 |
| 74HC151N | .68 |
| 74HC153N | 1.15 |
| 74HC154N | 3.50 |
| 74HC157N | 1.13 |
| 74HC158N | 1.13 |
| 74HC161N | 1.63 |
| 74HC162N | 1.63 |
| 74HC163N | 1.63 |
| 74HC164N | .68 |
| 74HC165N | 2.45 |
| 74HC166N | 1.63 |
| 74HC175N | 1.25 |
| 74HC193N | 2.03 |
| 74HC195N | 1.25 |
| 74HC221N | 1.50 |
| 74HC240N | 3.10 |
| 74HC241N | 3.10 |
| 74HC243N | 2.45 |
| 74HC244N | 3.10 |
| 74HC245N | 3.43 |
| 74HC251N | 1.25 |
| 74HC253N | 1.15 |
| 74HC257N | 1.25 |
| 74HC259N | 2.25 |
| 74HC266N | .88 |
| 74HC273N | 2.45 |
| 74HC299N | 5.08 |
| 74HC354N | 1.25 |
| 74HC365N | 1.25 |
| 74HC366N | 1.25 |
| 74HC367N | 1.25 |
| 74HC368N | 1.25 |
| 74HC373N | 3.60 |
| 74HC374N | 2.63 |
| 74HC390N | 1.10 |
| 74HC393N | 1.10 |
| 74HC534N | 3.60 |
| 74HC540N | 2.63 |
| 74HC541N | 2.63 |
| 74HC563N | 2.63 |
| 74HC573N | 2.63 |
| 74HC574N | 2.63 |
| 74HC640N | 3.03 |
| 74HC688N | 2.63 |
| 74HC688N | 2.13 |
| 74HC4002N | .68 |
| 74HC4020N | 1.75 |
| 74HC4040N | 1.75 |
| 74HC4049N | 1.38 |
| 74HC4050N | 1.38 |
| 74HC4060N | 2.03 |
| 74HC4075N | .68 |
| 74HC4078N | .68 |
| 74HC4511N | 4.75 |
| 74HC4538N | 2.53 |
| 74HC4543N | 4.30 |

### Signetics

| Part | Price |
|---|---|
| MC3410 | 8.00 |
| AA8012F | 16.88 |
| DAC08CN | 2.26 |
| MC1408-8 | 3.00 |
| MC1408-8N | 1.87 |
| NE5018N | 7.50 |
| NE5034N | 14.95 |
| NE5034F5 | 5.63 |
| NE5036N | 2.66 |
| NE5037N | 3.75 |
| MN5184-15 | 64K DRAM 150NS | 62.95/1; $17.50/9 |

### NEC Memory Chips

| Digi-Key Part No. | Description | Price |
|---|---|---|
| D4164C-20 | Dynamic RAM 16-Dip | $ 2.70 |
| D4164C-15 | Dynamic RAM 16-Dip | 2.70 |
| D41264C-20 | Dynamic RAM 18-Dip | 18.43 |
| D2147AD-25 | Static RAM 18-Dip | 9.23 |
| D2167D3 | 16,384 x 1-Bit Static N-MOS Ram | 20-Dip 7.76 |
| D4016C-3 | Static RAM | 24-Dip 4.50 |
| D446C-2 | Static RAM | 24-Dip 4.50 |
| D4361C70 | Static RAM | 24-Dip 45.00 |
| D4364C-20L | Static RAM | 28-Dip 7.31 |
| D2764C | EPROM (One-Time Programmable) | 28-Dip 9.23 |
| D2764D-2 | EPROM (Ultra-Violet Erasable) | 28-Dip 11.48 |
| D2712BD | 16,384 x 8-Bit N-MOS UV EPROM | 24-Dip 12.43 |
| D2712BC-3 | EPROM (One-Time Programmable) | 28-Dip 6.08 |
| D2725ED | EPROM (Ultra-Violet Erasable) | 28-Dip 19.69 |
| D27C64D-25 | EPROM (Ultra-Violet Erasable) | 28-Dip 13.05 |

### NEC Microprocessor Chips

| Digi-Key Part No. | Description | Price Each |
|---|---|---|
| D8748HC | Microcomputer | 40-Dip $13.75 |
| D8748HD | 8-Bit Microcomputer | 40-Dip 18.75 |
| D8749HC | High Performance Single Chip 8-Bit Microcomputer | 40-Dip 18.56 |
| D8085AC | Single Chip 8 Bit N-Channel Microprocessor | 40-Dip 3.38 |
| D8086D | 16-Bit Microprocessor | 40-Dip 16.88 |
| V30 | 8086 Replacement | 40-Dip 16.85 |
| D8088 | High Performance 8 Bit Microprocessor | 40-Dip 14.06 |
| V20 | 8088 Replacement | 40-Dip 14.85 |
| D780C-1 | High Performance CP/M Compatible NMOS 8 Bit Microprocessor | 40-Dip 3.38 |
| D7000BC | 8-Bit CMOS Microprocessor | 40-Dip 5.63 |

## INTEGRATED CIRCUITS

### 4000 CMOS

| Part | Price |
|---|---|
| 4000 | .50 |
| 4001B | .50 |
| 4002B | .50 |
| 4006A | 1.75 |
| 4007A | .50 |
| 4008B | 1.68 |
| 4008A | .83 |
| 4011B | .50 |
| 4011A | .50 |
| 4012B | .50 |
| 4013B | .63 |
| 4014B | 1.58 |
| 4015B | 1.45 |
| 4016B | .65 |
| 4017B | 1.35 |
| 4018B | 1.38 |
| 4019B | .83 |
| 4020B | 1.70 |
| 4021B | 1.58 |
| 4023B | .50 |
| 4024B | 1.08 |
| 4025B | .50 |
| 4026B | 3.50 |
| 4027B | .68 |
| 4028B | .83 |
| 4029B | 1.88 |
| 4030A | 4.50 |
| 4034B | 4.38 |
| 4035B | 1.38 |
| 4040B | 1.70 |
| 4041A | 1.75 |
| 4042B | 1.38 |
| 4043B | 1.50 |
| 4044B | 1.25 |
| 4046B | 1.38 |
| 4047B | 2.03 |
| 4048B | 1.25 |
| 4049B | .50 |
| 4050B | .50 |
| 4051B | 1.38 |
| 4052B | 1.38 |
| 4053B | 1.38 |
| 4054B | 2.25 |
| 4055B | 2.25 |
| 4056B | 2.25 |
| 4059A | 22.00 |
| 4066B | .50 |
| 4068B | .50 |
| 4069UB | .50 |
| 4070B | .50 |
| 4071B | .50 |
| 4072B | .50 |
| 4073B | .50 |
| 4075B | .50 |
| 4076B | .50 |
| 4077B | .50 |
| 4078B | .50 |
| 4081B | .50 |
| 4082B | .50 |
| 4085B | .50 |
| 4086B | .50 |
| 4089B | 3.13 |
| 4093B | .73 |
| 4094B | 2.70 |
| 4095B | 1.13 |
| 4096B | .90 |
| 4097B | 3.38 |
| 4098B | 1.50 |
| 4099B | 1.50 |
| 4502B | 1.50 |
| 4503B | .77 |
| 4504B | 1.13 |
| 4506B | .60 |
| 4507B | .60 |
| 4508B | 3.38 |
| 4510B | 1.23 |
| 4511B | 1.58 |
| 4512B | 1.10 |
| 4513B | 3.50 |
| 4514B | 3.65 |
| 4515B | 3.65 |
| 4516B | 1.23 |
| 4518B | 1.25 |
| 4519B | .75 |
| 4520B | 1.25 |
| 4521B | 2.70 |
| 4522B | 2.25 |
| 4526B | 2.25 |
| 4527B | 2.25 |
| 4528B | 1.34 |
| 4529B | 1.33 |
| 4532B | 2.45 |
| 4536B | 4.13 |
| 4538B | 1.35 |
| 4539B | 1.35 |
| 4541B | 11.00 |
| 4543B | 3.66 |
| 4547B | .95 |
| 4549B | 3.44 |
| 4551B | 1.35 |
| 4553B | 3.44 |
| 4555B | 1.35 |
| 4556B | 1.35 |
| 4560B | 3.44 |
| 4562B | 3.44 |
| 4566B | 3.44 |
| 4568B | 3.44 |
| 4572UB | 1.58 |

### Linear

| Part | Price |
|---|---|
| LM301AN | .63 |
| LM302N | .83 |
| LM304H | 1.35 |
| LM305AH | .83 |
| LM306N | .83 |
| LM307N | 2.69 |
| LM308N | .96 |
| LM309H | 1.07 |
| LM309K | .83 |
| LM310N | 1.35 |
| LM311N | .75 |
| LM312H | 1.35 |
| LM317K | 3.75 |
| LM317MP | 1.51 |
| LM318N | 3.16 |
| LM319N | 1.35 |
| LM320LZ-5.0 | 1.38 |
| LM320LZ-12 | 1.38 |
| LM320MP-5 | 1.38 |
| LM320MP-12 | 2.61 |
| LM320MP-15 | 2.61 |
| LM322N | 2.20 |
| LM323K | 8.94 |
| LM324N | .96 |
| LM326N | 4.54 |
| LM327N | 3.71 |
| LM329DZ | .83 |
| LM331N | 5.78 |
| LM334Z | 1.69 |
| LM335Z | 1.93 |
| LM336BZ-2.5 | 1.38 |
| LM336Z-5.0 | 1.38 |
| LM337K | 7.43 |
| LM337MP | 1.65 |
| LM337T | 2.61 |
| LM338K | 10.04 |
| LM339N | .96 |
| LM340K-5 | 3.03 |
| LM340K-12 | 3.03 |
| LM340KC 15 | 3.03 |
| LM340T-5 | .96 |
| LM340T-12 | .96 |
| LM340T-15 | .96 |
| LM341P-5 | 1.06 |
| LM341P-12 | 1.06 |
| LM341P-15 | 1.06 |
| LM346N | 3.82 |
| LM348N | 1.38 |
| LM349N | 1.79 |
| LM350K | 7.70 |
| LM350T | 3.17 |
| LM358N | .83 |
| LM359N | 2.20 |
| LM376N | .77 |
| LM377N | 3.30 |
| LM378N | 4.25 |
| LM380N | 1.38 |
| LM380N 8 | 1.38 |
| LM381N | 2.38 |
| LM382N | 2.34 |
| LM383AT | 3.71 |
| LM384N | 1.38 |
| LM386N-1 | 1.10 |
| LM387N | 2.06 |
| LM388N-3 | 2.10 |
| LM389N | 1.84 |
| LM390N | 3.50 |
| LM391N80 | 1.51 |
| LM391N80 | 1.79 |
| LM393N | .99 |
| LM393N | .77 |
| LM395T | 2.20 |
| LM395K | 2.20 |
| LM395N | 9.63 |
| LM399H | 22.00 |
| LM566CN | 1.32 |
| LM566CN | 1.32 |
| LM567CN | 1.32 |
| LM567CN | .96 |
| LM723CN | .83 |
| LM725CN | 6.56 |
| LM733CN | 1.02 |
| LM741CN | .69 |
| LM746CN | .83 |
| LM748CN | .83 |
| LM1310N | 1.16 |
| LM1458N | .77 |
| LM1496N | 1.65 |
| LM1800N | 1.65 |
| LM1812N | 11.28 |
| LM1815N | 3.44 |
| LM1845N | 11.00 |
| LM1870N | 5.50 |
| LM1871N | 5.50 |
| LM1872N | 5.80 |
| LM1875N | 2.94 |
| LM1877N9 | 2.50 |
| LM1889N | 4.13 |
| NSC800N | 21.25 |
| LM2901N | 1.24 |
| LM2902N | 1.34 |
| LM2903N | 1.34 |
| LM2904N | .59 |
| LM2905N | 4.13 |
| LM2907N | 1.65 |
| LM2907N-8 | 3.90 |
| LM3911N | 3.44 |
| LM3909N | 1.35 |
| LM3914N | 3.44 |
| LM3915N | 3.44 |
| LM3916N | 3.44 |
| LM3524N | 4.13 |
| LM3900N | 1.10 |
| LM3905N | 1.65 |
| LM3909N | 1.38 |
| LM3911N | 2.06 |
| LM3914N | 3.44 |
| LM3915N | 3.44 |
| LM3916N | 3.44 |
| DAC1022LCN | 7.00 |
| MM5863EST | 2.50 |
| MM5863AAN | 2.50 |

### A/D& D/A

| Part | Price |
|---|---|
| ADC0803LCN | 7.75 |
| ADC0804LCN | 5.00 |
| ADC0805LCN | 5.63 |
| ADC0808CCN | 12.68 |
| ADC0809CCN | 14.63 |
| ADC0816CCN | 18.85 |
| ADC0817CCN | 11.25 |
| ADC0820CCN | 5.25 |
| ADC1001CCN | 32.50 |
| ADC1021CCN | 34.00 |
| ADC1022CCN | 10.50 |
| ADC1205CCN | 13.70 |
| ADC1210CCN | 15.63 |
| ADC1211CCN | 15.63 |
| ADC1225CCN | 15.63 |
| DAC0800LCN | 3.38 |
| DAC0806LCN | 4.50 |
| DAC0808LCN | 2.63 |
| DAC0830LCN | 6.80 |
| DAC0832LCN | 3.75 |
| DAC1020LCN | 10.50 |
| DAC1022LCN | 7.00 |
| MM5863EST | 2.50 |
| MM5863AAN | 2.50 |

### Interface

| Part | Price |
|---|---|
| DS1488N | 1.35 |
| DS1488AN | 1.35 |
| DS1489N | 1.35 |
| 75450N | .90 |
| 75451N | .88 |
| 75452N | .88 |
| 75453N | .88 |
| 75454N | .88 |
| 75491N | 1.80 |
| 75492N | 1.42 |

### 4116 200 nsec 16,384x1 D Ram

| Part No. | 8 | 32 | 128 | $12 | Price Per Pak Of 1024 |
|---|---|---|---|---|---|
| 4116N-ND | 15.12 | 57.12 | 215.00 | 806.40 | 1397.75 |
| 5290N-ND | 15.12 | 57.12 | 215.00 | 806.40 | 1397.75 |
| Price Each | 1.89 | 1.785 | 1.68 | 1.575 | 1.365 |

## T I I.C. SOCKETS

### SOLDER TAIL DIP SOCKETS

- Single beam
- Low profile
- YOUR CHOICE: TIN OR GOLD*

*Gold plated, all mini-dot solder tails are gold solder.

**TIN PLATED SOLDER TAIL** Min. 200 Microinches Tin
-40° to +70°C

| Part No. | Description | 1 | 10 | 100 |
|---|---|---|---|---|
| C8008 | 8 pin solder tail, tin | .13 | 1.15 | 10.50 |
| C8014 | 14 pin solder tail, tin | .15 | 1.45 | 12.00 |
| C8016 | 16 pin solder tail, tin | .17 | 1.60 | 13.00 |
| C8018 | 18 pin solder tail, tin | .20 | 1.90 | 17.00 |
| C8020 | 20 pin solder tail, tin | .23 | 2.10 | 20.00 |
| C8022 | 22 pin solder tail, tin | .25 | 2.25 | 21.00 |
| C8024 | 24 pin solder tail, tin | .28 | 2.50 | 23.00 |
| C8028 | 28 pin solder tail, tin | .32 | 2.90 | 27.00 |
| C8040 | 40 pin solder tail, tin | .46 | 4.20 | 39.00 |

**GOLD INLAY SOLDER TAIL** Min. 50 Microinches Gold
-55° to +125°C

| Part No. | Description | 1 | 10 | 100 |
|---|---|---|---|---|
| C8008 | 8 pin solder tail, gold | .34 | 3.20 | 30.00 |
| C8014 | 14 pin solder tail, gold | .44 | 4.20 | 40.00 |
| C8016 | 16 pin solder tail, gold | .50 | 4.70 | 45.00 |
| C8018 | 18 pin solder tail, gold | .57 | 5.40 | 52.00 |
| C8020 | 20 pin solder tail, gold | .63 | 5.90 | 57.00 |
| C8022 | 22 pin solder tail, gold | .70 | 6.60 | 64.00 |
| C8024 | 24 pin solder tail, gold | .76 | 7.30 | 70.00 |
| C8028 | 28 pin solder tail, gold | .87 | 7.90 | 73.00 |
| C8040 | 40 pin solder tail, gold | 1.12 | 9.90 | 97.00 |

### WIRE WRAP DIP SOCKETS

- Standard profile
- Universal mounting and packaging capabilities
- Contacts accommodate .018" through .021" rec. or round dual-in-line leads.
- Wire wrap posts held to true position of .015" providing a true position of .020" on boards for efficient automatic wire wrapping*
- YOUR CHOICE: TIN OR GOLD*

*Gold plated, .30 microinch gold over 50 microinch nickel

- TEXAS INSTRUMENTS QUALITY

**TIN PLATED WIRE WRAP** Min. 200 Microinches Tin

| Part No. | Description | 1 | 10 | 100 |
|---|---|---|---|---|
| C8108 | 8 pin wire wrap, tin | .39 | 3.60 | 34.00 |
| C8114 | 14 pin wire wrap, tin | .54 | 4.80 | 46.00 |
| C8118 | 18 pin wire wrap, tin | .67 | 5.60 | 55.00 |
| C8120 | 20 pin wire wrap, tin | .73 | 6.70 | 65.00 |
| C8122 | 22 pin wire wrap, tin | .76 | 7.50 | 74.00 |
| C8124 | 24 pin wire wrap, tin | .83 | 8.20 | 81.00 |
| C8128 | 28 pin wire wrap, tin | .91 | 8.90 | 88.00 |
| C8140 | 40 pin wire wrap, tin | 1.04 | 10.30 | 102.00 |
| C8140 | 40 pin wire wrap, tin | 1.42 | 13.90 | 138.00 |

**GOLD INLAY WIRE WRAP** Min. 50 Microinches Gold

| Part No. | Description | 1 | 10 | 100 |
|---|---|---|---|---|
| C8108 | 8 pin wire wrap, gold | .59 | 5.80 | 57.00 |
| C8114 | 14 pin wire wrap, gold | .79 | 7.80 | 77.0 |
| C8118 | 18 pin wire wrap, gold | .95 | 9.40 | 93.00 |
| C8118 | 18 pin wire wrap, gold | .99 | 9.80 | 97.00 |
| C8120 | 20 pin wire wrap, gold | 1.15 | 11.80 | 117.00 |
| C8122 | 22 pin wire wrap, gold | 1.29 | 12.80 | 127.00 |
| C8124 | 24 pin wire wrap, gold | 1.39 | 13.80 | 137.00 |
| C8128 | 28 pin wire wrap, gold | 1.69 | 16.80 | 167.00 |
| C8140 | 40 pin wire wrap, gold | 2.29 | 22.80 | 227.00 |

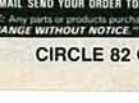
## Silicon Transistors

| DIGI-KEY Part No. | 1 | 10 | 100 | 1,000 |
|---|---|---|---|---|
| 2N3055 | 2.02 | 16.80 | 151.20 | 1344.00 |
| 2N3439 | .33 | 2.30 | 18.90 | 172.35 |
| 2N3906 | .23 | 2.20 | 18.90 | 172.35 |
| 2N4124 | .24 | 2.27 | 19.50 | 178.75 |
| 2N4126 | .24 | 2.27 | 19.50 | 178.75 |
| 2N4401 | .23 | 2.20 | 18.90 | 173.25 |
| 2N4403 | .23 | 2.20 | 18.90 | 173.25 |
| 2N4410 | .33 | 3.15 | 27.00 | 247.50 |
| 2N4416 | .68 | 6.50 | 56.00 | 513.00 |
| 2N5210 | .23 | 2.20 | 18.90 | 173.25 |
| 2N5400 | .34 | 3.25 | 28.00 | 256.50 |
| 2PU01A | .45 | 4.20 | 36.00 | 330.00 |
| 2N4403 | .45 | 4.20 | 36.00 | 330.00 |
| ADC0803 | .45 | 4.20 | 36.00 | 330.00 |
| 2PU10 | .45 | 4.20 | 36.00 | 330.00 |
| 2PU51A | .45 | 4.20 | 36.00 | 330.00 |
| 2N3904 | .45 | 4.20 | 36.00 | 330.00 |
| MJE172 | .67 | 6.30 | 54.00 | 495.00 |
| MJE182 | .57 | 5.40 | 46.00 | 422.00 |
| MJE371 | .87 | 8.10 | 78.00 | 715.00 |
| MJE521 | .86 | 8.00 | 69.00 | 632.50 |
| MJE802 | .97 | 9.10 | 78.00 | 715.00 |
| MJE803 | .56 | 5.25 | 45.00 | 412.50 |
| PN2222A | .23 | 2.20 | 18.90 | 173.25 |
| MPS6568A | .23 | 2.20 | 18.90 | 173.25 |
| MPS2907A | .23 | 2.20 | 18.90 | 173.25 |
| MPS6534 | .23 | 2.20 | 18.90 | 173.25 |
| MPS6538A | .23 | 2.20 | 18.90 | 173.25 |
| TIP29 | .60 | 5.25 | 45.00 | 375.00 |
| TIP29A | .64 | 5.95 | 51.00 | 425.00 |
| TIP29B | .68 | 5.95 | 51.00 | 425.00 |
| TIP29C | .68 | 5.95 | 51.00 | 425.00 |
| TIP30 | .68 | 5.95 | 51.00 | 425.00 |
| TIP30A | .72 | 6.65 | 57.00 | 475.00 |
| TIP30B | .76 | 6.65 | 57.00 | 475.00 |
| TIP30C | .80 | 7.00 | 60.00 | 500.00 |
| TIP31 | .64 | 5.60 | 48.00 | 400.00 |
| TIP31A | .68 | 5.95 | 51.00 | 425.00 |
| TIP31B | .72 | 6.30 | 54.00 | 450.00 |
| TIP31C | .76 | 6.65 | 57.00 | 475.00 |
| TIP32 | .84 | 7.00 | 60.00 | 500.00 |
| TIP32A | .84 | 7.35 | 63.00 | 525.00 |
| TIP32B | .88 | 7.70 | 66.00 | 550.00 |
| TIP32C | .92 | 8.05 | 68.00 | 575.00 |
| TIP41 | .92 | 8.05 | 68.00 | 575.00 |
| TIP41A | .96 | 8.40 | 72.00 | 600.00 |
| TIP41B | 1.00 | 8.75 | 75.00 | 625.00 |
| TIP41C | 1.08 | 9.45 | 81.00 | 675.00 |
| TIP42A | 1.12 | 9.80 | 84.00 | 700.00 |
| TIP42B | 1.16 | 10.15 | 87.00 | 725.00 |
| TIP42C | 1.20 | 10.50 | 90.00 | 750.00 |
| TIP51C | .75 | 7.00 | 60.00 | 550.00 |
| TIP52C | .76 | 6.65 | 57.00 | 475.00 |
| TIP111 | .80 | 7.00 | 60.00 | 500.00 |
| TIP112 | .84 | 7.35 | 63.00 | 525.00 |
| TIP115 | .96 | 8.40 | 72.00 | 600.00 |
| TIP116 | 1.00 | 8.75 | 75.00 | 625.00 |

### 1 AMP SILICON RECTIFIERS

| Part No. | Description | Pkg. | 1 | 10 | 100 | 1,000 |
|---|---|---|---|---|---|---|
| 1N4001 | 50 PIV | DO-41 | .80 | 7.00 | 60.00 | 515.00 |
| 1N4002 | 100 PIV | DO-41 | .80 | 7.00 | 60.00 | 540.00 |
| 1N4003 | 200 PIV | DO-41 | .80 | 7.50 | 64.00 | 563.00 |
| 1N4004 | 400 PIV | DO-41 | .80 | 7.50 | 68.00 | 588.00 |
| 1N4005 | 600 PIV | DO-41 | 1.00 | 9.00 | 74.00 | 625.00 |
| 1N4006 | 800 PIV | DO-41 | 1.00 | 9.00 | 80.00 | 681.00 |
| 1N4007 | 1000 PIV | DO-41 | 1.00 | 9.00 | 100.00 | 710.00 |
| 1N4148 | Ultra Fast Switching Diode | DO-41 | .60 | 5.00 | 29.58 | 211.25 |

### 3 AMP SILICON RECTIFIERS




| Part No. | Description | Pkg. | 1 | 10 | 100 | 1,000 |
|---|---|---|---|---|---|---|
| 1N5400 | 3 Amp 50PIV | Plastic | .28 | 2.96 | 22.80 | 199.50 |
| 1N5401 | 3 Amp 100PIV | Plastic | .30 | 2.70 | 24.00 | 210.00 |
| 1N5402 | 3 Amp 200PIV | Plastic | .31 | 2.82 | 25.20 | 220.50 |
| 1N5404 | 3 Amp 400PIV | Plastic | .33 | 2.97 | 26.40 | 231.00 |
| 1N5406 | 3 Amp 600PIV | Plastic | .35 | 3.15 | 28.00 | 245.00 |
| 1N5407 | 3 Amp 800PIV | Plastic | .40 | 3.60 | 32.00 | 280.00 |
| 1N5408 | 3 Amp 1000PIV | Plastic | .50 | 4.50 | 40.00 | 350.00 |

## 5% Carbon Film Resistors

Available in 1/8, 1/4 & 1/2 Watt

| Wattage Rating | 1/8W | 1/4W | 1/2W |
|---|---|---|---|
| Max. Working Voltage | 200V | 250V | 350V |
| Rated Ambient Temp. | 70°C | | |
| Operating Temp. Range | -55°C to +150°C | | |
| Dimension "L" | 3.80 | 6.50 | 9.50 |
| Dimension "D" | 1.90 | 2.30 | 3.20 |
| Dimension "d" | 0.45 | 0.60 | 0.80 |

5% Carbon Film Resistor Values in Ohms - 1.0 to 4.7M

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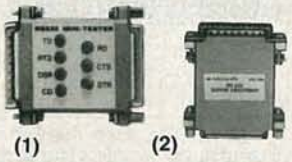
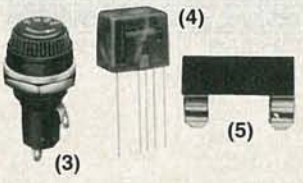


(1) (2)

**(1) RS-232 Inline Tester.** Dual-color LEDs indicate status of TD, RTS, DSR, CD, RD, CTS and DTR lines. #276-1401 . . . . . **14.95**

**(2) RS-232 Spike Protector.** Stops transients from reaching CPU/peripherals. #276-1402 . . . . . **16.95**

### "Black-Box" Bargains



(3) (4) (5)

**(3) Panel-Mount Fuse Holder.** For 5 x 20 mm fuses. UL recognized. #270-362 . . . . . **1.29**

**(4) Mini SPDT Relay.** 1 amp at 125 VAC. Coil: 6-9 VDC, 500 ohm. #275-004 . . . . . **2.99**

**(5) Fuse Adapt.** #270-1219 . . **99¢**

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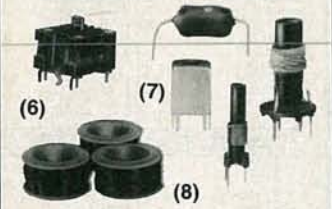
### Builders' Treasure



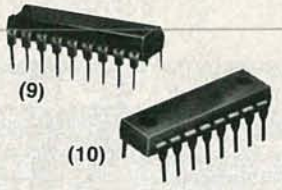
(6) (7) (8)

**(6) Two-Section Variable Cap, 335 pF.** PC-mount. #272-1337 . . . . **4.95**

**(7) Inductor Assortment.** 30-piece set. Includes small coils, chokes and transformers. #273-1601 . . . . . **1.98**

**(8) Magnet Wire.** 22, 26 and 30-gauge spools. #278-1345 . . . . **4.49**

### Experimenters' ICs



(9) (10)

**(9) TDA7000, FM Receiver on a Chip.** 70 KHz IF means easy-to-build receiver projects. With data. #276-1304 . . . . . **5.95**

**(10) UMC 3482, Melody Synthesizer IC.** With 12 tunes. For 1.5 VDC, 16-pin DIP. #276-1797 . . **2.99**

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(11) (12) (13) (14)

**First Quality Data Connectors**

Solder-Type "D" Submini Connectors.

| Fig. | Type | Positions | Cat. No. | Each |
|---|---|---|---|---|
| 11 | Male | 9 | 276-1537 | 1.49 |
| 12 | Female | 9 | 276-1538 | 2.49 |
| 13 | Hood | 9 | 276-1539 | 1.99 |

| Type | Positions | Cat. No. | Each |
|---|---|---|---|
| Male | 25 | 276-1547 | 1.99 |
| Female | 25 | 276-1548 | 2.99 |
| Hood | 25 | 276-1549 | 1.99 |

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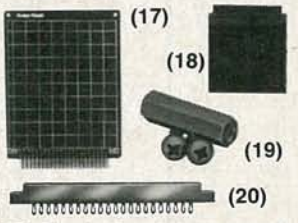
### PC and Perfboards



(17) (18) (19) (20)

**(17) Plug-In Board With Ground Plane.** #276-188 . . . . . **4.99**

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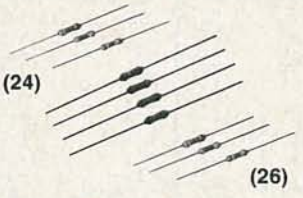
**(23) Loud PC-Mount Buzzer.** 2800 Hz. 78 dB. Requires 3-20 VDC. #273-065 . . . . . **2.49**

### Resistor Assortments



(24) (26)

**(24) 1/4-Watt Carbon Film.** 500 pieces in 54 popular values. From 10 ohms to 10 megohms. #271-312 . . . . . **7.95**

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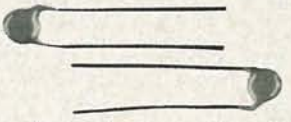

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Rated at 50 WVDC except 272-126/130 rated 500 WVDC.

| pF | Cat. No. | 2-Pk. |
|---|---|---|
| 4.7 | 272-120 | .39 |
| 47 | 272-121 | .39 |
| 100 | 272-123 | .39 |
| 220 | 272-124 | .39 |
| 470 | 272-125 | .39 |

| µF | Cat. No. | 2-Pk. |
|---|---|---|
| .001 | 272-126 | .49 |
| .0047 | 272-130 | .49 |
| .01 | 272-131 | .49 |
| .047 | 272-134 | .49 |
| .1 | 272-135 | .59 |

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| Part No. | 1-9 | 10+ | Part No. | 1-9 | 10+ |
|---|---|---|---|---|---|
| 7400 | .29 | .19 | 7485 | .65 | .55 |
| 7402 | .29 | .19 | 7486 | .45 | .35 |
| 7404 | .29 | .19 | 7489 | 2.05 | 1.95 |
| 7405 | .35 | .25 | 7490 | .49 | .39 |
| 7406 | .39 | .29 | 7493 | .45 | .35 |
| 7407 | .39 | .29 | 74121 | .45 | .35 |
| 7408 | .35 | .25 | 74123 | .55 | .45 |
| 7410 | .29 | .19 | 74125 | .55 | .45 |
| 7414 | .49 | .39 | 74126 | .69 | .59 |
| 7416 | .39 | .29 | 74143 | 3.95 | 3.85 |
| 7417 | .39 | .29 | 74150 | 1.35 | 1.25 |
| 7420 | .35 | .25 | 74154 | 1.35 | 1.25 |
| 7430 | .35 | .25 | 74158 | 1.59 | 1.49 |
| 7432 | .39 | .29 | 74173 | .85 | .75 |
| 7438 | .39 | .29 | 74174 | .59 | .49 |
| 7442 | .55 | .45 | 74175 | .59 | .49 |
| 7445 | .79 | .69 | 74176 | .99 | .89 |
| 7446 | .89 | .79 | 74181 | 1.95 | 1.85 |
| 7447 | .89 | .79 | 74189 | 1.95 | 1.85 |
| 7448 | 2.05 | 1.95 | 74193 | .79 | .69 |
| 7472 | .89 | .79 | 74198 | 1.85 | 1.75 |
| 7473 | .39 | .29 | 74221 | .99 | .89 |
| 7474 | .39 | .29 | 74273 | 1.95 | 1.85 |
| 7475 | .49 | .39 | 74365 | .65 | .55 |
| 7476 | .45 | .35 | 74367 | .65 | .55 |

## 74LS

| | | | | | |
|---|---|---|---|---|---|
| 74LS00 | .29 | .19 | 74LS165 | .75 | .65 |
| 74LS02 | .29 | .19 | 74LS166 | .99 | .89 |
| 74LS04 | .35 | .25 | 74LS173 | .59 | .49 |
| 74LS05 | .35 | .25 | 74LS174 | .49 | .39 |
| 74LS06 | 1.09 | .99 | 74LS175 | .49 | .39 |
| 74LS07 | 1.09 | .99 | 74LS189 | 4.59 | 4.49 |
| 74LS08 | .29 | .19 | 74LS191 | .59 | .49 |
| 74LS10 | .29 | .19 | 74LS193 | .79 | .69 |
| 74LS14 | .49 | .39 | 74LS221 | .69 | .59 |
| 74LS27 | .35 | .25 | 74LS240 | .69 | .59 |
| 74LS30 | .29 | .19 | 74LS243 | .69 | .59 |
| 74LS32 | .35 | .25 | 74LS244 | .69 | .59 |
| 74LS42 | .49 | .39 | 74LS245 | .89 | .79 |
| 74LS47 | .99 | .89 | 74LS259 | .99 | .89 |
| 74LS73 | .39 | .29 | 74LS273 | .89 | .79 |
| 74LS74 | .35 | .25 | 74LS279 | .49 | .39 |
| 74LS75 | .39 | .29 | 74LS322 | 4.05 | 3.95 |
| 74LS76 | .55 | .45 | 74LS365 | .49 | .39 |
| 74LS85 | .59 | .49 | 74LS366 | .49 | .39 |
| 74LS86 | .35 | .25 | 74LS367 | .49 | .39 |
| 74LS90 | .49 | .39 | 74LS368 | .49 | .39 |
| 74LS93 | .49 | .39 | 74LS373 | .79 | .69 |
| 74LS123 | .59 | .49 | 74LS374 | .79 | .69 |
| 74LS125 | .49 | .39 | 74LS393 | .89 | .79 |
| 74LS138 | .49 | .39 | 74LS590 | 6.05 | 5.95 |
| 74LS139 | .49 | .39 | 74LS624 | 2.05 | 1.95 |
| 74LS154 | 1.09 | .99 | 74LS629 | 2.95 | 2.85 |
| 74LS157 | .45 | .35 | 74LS640 | 1.09 | .99 |
| 74LS158 | .45 | .35 | 74LS645 | 1.09 | .99 |
| 74LS163 | .59 | .49 | 74LS670 | 1.09 | .99 |
| 74LS164 | .59 | .49 | 74LS688 | 2.39 | 2.29 |

## 74S/PROMS*

| | | | |
|---|---|---|---|
| 74S00 | .29 | 74S188* | 1.49 |
| 74S04 | .29 | 74S189 | 1.69 |
| 74S08 | .35 | 74S196 | 2.49 |
| 74S10 | .29 | 74S240 | 1.49 |
| 74S32 | .35 | 74S244 | 1.49 |
| 74S74 | .45 | 74S253 | .79 |
| 74S85 | 1.79 | 74S287* | 1.49 |
| 74S86 | .49 | 74S288* | 1.49 |
| 74S124 | 2.75 | 74S373 | 1.49 |
| 74S174 | .79 | 74S374 | 1.49 |
| 74S175 | .79 | 74S472* | 2.95 |

## 74F

| | | | |
|---|---|---|---|
| 74F00 | .29 | 74F139 | .69 |
| 74F04 | .29 | 74F157 | .69 |
| 74F08 | .29 | 74F193 | 2.95 |
| 74F10 | .29 | 74F240 | .99 |
| 74F32 | .29 | 74F244 | .99 |
| 74F74 | .39 | 74F253 | .69 |
| 74F86 | .39 | 74F373 | .99 |
| 74F138 | .69 | 74F374 | .99 |

## CD—CMOS

| | | | |
|---|---|---|---|
| CD4001 | .19 | CD4076 | .59 |
| CD4008 | .69 | CD4081 | .25 |
| CD4011 | .19 | CD4082 | .25 |
| CD4013 | .29 | CD4093 | .35 |
| CD4016 | .29 | CD4094 | .89 |
| CD4017 | .49 | CD40103 | 2.49 |
| CD4018 | .59 | CD40107 | .49 |
| CD4020 | .59 | CD40109 | .79 |
| CD4024 | .49 | CD4510 | .69 |
| CD4027 | .35 | CD4511 | .69 |
| CD4030 | .29 | CD4520 | .75 |
| CD4040 | .65 | CD4522 | .79 |
| CD4049 | .29 | CD4538 | .79 |
| CD4050 | .29 | CD4541 | .89 |
| CD4051 | .59 | CD4543 | .79 |
| CD4052 | .59 | CD4553 | 4.95 |
| CD4053 | .59 | CD4555 | .79 |
| CD4063 | 1.49 | CD4559 | 7.95 |
| CD4066 | .29 | CD4566 | 2.49 |
| CD4067 | 1.29 | CD4583 | .89 |
| CD4069 | .25 | CD4584 | .39 |
| CD4070 | .25 | CD4585 | .89 |
| CD4071 | .25 | MC14411P | 8.95 |
| CD4072 | .25 | MC14490P | 4.49 |

## MICROPROCESSOR COMPONENTS

### MISCELLANEOUS CHIPS

| Part No. | Price |
|---|---|
| D765AC | 4.95 |
| WD9216 | 6.95 |
| 95H90 | 9.95 |
| **Z80, Z80A, Z80B SERIES** | |
| Z80 | 1.25 |
| Z80-CTC | 1.79 |
| Z80-DART | 4.95 |
| Z80-PIO | 1.79 |
| Z80A | 1.69 |
| Z80A-CTC | 1.79 |
| Z80A-DART | 4.95 |
| Z80A-PIO | 1.69 |
| Z80A-SIO/0 | 5.75 |
| Z80B | 3.49 |
| Z80B-CTC | 3.95 |
| Z80B-PIO | 4.29 |
| **6500/6800/68000 SER.** | |
| 6502 | 2.65 |
| 65C02 (CMOS) | 8.95 |
| 6520 | 1.95 |
| 6522 | 3.95 |
| 6532 | 6.49 |
| 6551 | 4.49 |
| 65C802 (CMOS) | 19.95 |
| 6800 | 1.95 |
| 6802 | 3.95 |
| 6810 | 1.25 |
| 6821 | 1.75 |
| 6840 | 3.95 |

### 6500/6800/68000 Cont.

| Part No. | Price |
|---|---|
| 6845 | 3.95 |
| 6850 | 1.95 |
| 6852 | 1.49 |
| MC68000L8 | 11.95 |
| MC68000L10 | 13.95 |
| MC68010L10 | 49.95 |
| MC68020RC12B | 169.95 |
| MC68881RC12A | 149.95 |
| **8000 SERIES** | |
| 8031 | 3.95 |
| 80C31 | 9.95 |
| 8035 | 1.95 |
| 8073 | 9.95 |
| 8080A | 2.95 |
| 8085A | 2.49 |
| 8086 | 5.95 |
| 8086-2 | 6.95 |
| 8087 (5MHz) | 129.95 |
| 8087-1 (10MHz) | 229.95 |
| 8087-2 (8MHz) | 169.95 |
| 8088 | 6.49 |
| 8088-2 | 8.95 |
| 8116 | 4.95 |
| 8155 | 2.49 |
| 8155-2 | 3.49 |
| 8156 | 3.95 |
| 8202 | 5.95 |
| 8203 | 9.95 |
| 8212 | 1.49 |
| 8224 | 2.25 |

### 8000 SERIES Cont.

| Part No. | Price |
|---|---|
| 8228 | 2.95 |
| 8237-5 | 4.95 |
| 8243 | 2.25 |
| 8250A | 6.49 |
| 8250B (For IBM) | 6.95 |
| 8251A | 1.89 |
| 8253-5 | 1.95 |
| 8254 | 4.95 |
| 8255A-5 | 1.89 |
| 8257-5 | 1.95 |
| 8259-5 | 2.25 |
| 8272 | 4.95 |
| 8279-5 | 2.95 |
| 8741 | 9.95 |
| 8742 | 29.95 |
| 8748 (25V) | 7.95 |
| 8748H (HMOS) (21V) | 9.95 |
| 8749 | 9.95 |
| 8751 | 39.95 |
| 8755 | 14.95 |
| **DATA ACQUISITION** | |
| ADC0804LCN | 3.19 |
| ADC0808CCN | 5.95 |
| ADC0809CCN | 3.95 |
| ADC0816CCN | 11.95 |
| ADC1205CCJ-1 | 19.95 |
| DAC0808LCN | 1.95 |
| DAC1008LCN | 4.95 |
| AY-3-1015D | 4.95 |
| AY-5-1013A | 2.95 |

## MICROPROCESSOR SALE!

| Part No. | | Price |
|---|---|---|
| 8052AHBASIC | CPU w/BASIC Interpreter | $ 29.95 |
| MC68008L8 | 32-Bit MPU (8-Bit Data Bus) | $ 19.95 |
| MC68701 | 8-Bit EPROM Microcomputer | $ 14.95 |
| MC68705P3S | 8-Bit EPROM Microcomputer | $ 14.95 |
| MC68705U3L | 8-Bit EPROM Microcomputer | $ 10.95 |
| 80286-10 | 16-Bit Hi Performance MPU | $ 99.95 |
| 80287-8 | Math Co-processor (8MHz) | $299.95 |
| 80287-10 | Math Co-processor (10MHz) | $329.95 |
| 80387-16 | Math Co-processor (16MHz) GRID ARRAY | $494.95 |

### DYNAMIC RAMS

| Part No. | | | Price |
|---|---|---|---|
| 4116-15 | 16,384 x 1 | (150ns) | .89 |
| 4128-20 | 131,072 x 1 | (200ns) (Piggyback) | 3.25 |
| 4164-120 | 65,536 x 1 | (120ns) | 1.75 |
| 4164-150 | 65,536 x 1 | (150ns) | 1.25 |
| 4164-200 | 65,536 x 1 | (200ns) | .99 |
| TMS4416-12 | 16,384 x 4 | (120ns) | 3.49 |
| 8118 | 16,384 x 1 | (120ns) | .49 |
| 41256-100 | 262,144 x 1 | (100ns) | 4.95 |
| 41256-120 | 262,144 x 1 | (120ns) | 3.95 |
| 41256-150 | 262,144 x 1 | (150ns) | 3.25 |
| 50464-15 | 65,536 x 4 | (150ns) (4464) | 4.95 |
| 511000P-10 | 1,048,576 x 1 | (100ns) 1 Meg | 34.95 |
| 514256P-10 | 262,144 x 4 | (100ns) 1 Meg | 29.95 |

### STATIC RAMS

| Part No. | | | Price |
|---|---|---|---|
| 2016-12 | 2048 x 8 | (120ns) | 1.69 |
| 2018-45 | 2048 x 8 | (45ns) | 6.95 |
| 2102-2L | 1024 x 1 | (250ns) Low Power | 1.95 |
| 2114N | 1024 x 4 | (450ns) | .99 |
| 2114N-2L | 1024 x 4 | (200ns) Low Power | 1.49 |
| 21C14 | 1024 x 4 | (200ns) (CMOS) | .49 |
| 2149 | 1024 x 4 | (45ns) | 2.49 |
| 5101 | 256 x 4 | (450ns) CMOS | 1.95 |
| 6116P-3 | 2048 x 8 | (150ns) CMOS | 1.89 |
| 6116LP-3 | 2048 x 8 | (150ns) LP CMOS | 1.95 |
| 6264LP-12 | 8192 x 8 | (120ns) LP CMOS | 4.25 |
| 6264P-15 | 8192 x 8 | (150ns) CMOS | 3.49 |
| 6264LP-15 | 8192 x 8 | (150ns) LP CMOS | 3.75 |
| 6514 | 1024 x 4 | (350ns) CMOS | 3.49 |
| 43256-15L | 32,768 x 8 | (150ns) Low Power | 11.95 |

### EPROMS

| Part No. | | | Price |
|---|---|---|---|
| TMS2516 | 2048 x 8 | (450ns) 25V | 6.95 |
| TMS2532 | 4096 x 8 | (450ns) 25V | 6.95 |
| TMS2532A | 4096 x 8 | (450ns) 21V | 5.95 |
| TMS2564 | 8192 x 8 | (450ns) 25V | 9.95 |
| TMS2716 | 2048 x 8 | (450ns) 3 Voltage | 9.95 |
| 1702A | 256 x 8 | (1µs) | 6.95 |
| 2708 | 1024 x 8 | (450ns) | 4.95 |
| 2716 | 2048 x 8 | (450ns) 25V | 3.75 |
| 2716-1 | 2048 x 8 | (350ns) 25V | 4.25 |
| 27C16 | 2048 x 8 | (450ns) 25V (CMOS) | 5.49 |
| 2732 | 4096 x 8 | (450ns) 25V | 3.95 |
| 2732A-20 | 4096 x 8 | (200ns) 21V | 4.25 |
| 2732A-25 | 4096 x 8 | (250ns) 21V | 3.95 |
| 27C32 | 4096 x 8 | (450ns) 25V (CMOS) | 5.95 |
| 2764-20 | 8192 x 8 | (200ns) 21V | 4.25 |
| 2764-25 | 8192 x 8 | (250ns) 21V | 3.75 |
| 2764A-25 | 8192 x 8 | (250ns) 12.5V | 3.95 |
| 2764-45 | 8192 x 8 | (450ns) 21V | 2.95 |
| 27C64-15 | 8192 x 8 | (150ns) 21V (CMOS) | 6.49 |
| 27128-20 | 16,384 x 8 | (200ns) 21V | 6.95 |
| 27128-25 | 16,384 x 8 | (250ns) 21V | 5.95 |
| 27128A-25 | 16,384 x 8 | (250ns) 12.5V | 5.25 |
| 27C128-25 | 16,384 x 8 | (250ns) 21V (CMOS) | 6.95 |
| 27256-20 | 32,768 x 8 | (200ns) 12.5V | 6.95 |
| 27256-25 | 32,768 x 8 | (250ns) 12.5V | 5.95 |
| 27C256-25 | 32,768 x 8 | (250ns) 12.5V (CMOS) | 7.95 |
| 27512-20 | 65,536 x 8 | (200ns) 12.5V | 13.49 |
| 27512-25 | 65,536 x 8 | (250ns) 12.5V | 11.95 |
| 68764 | 8192 x 8 | (450ns) 25V | 13.95 |

### EEPROMS

| Part No. | | | Price |
|---|---|---|---|
| 2816A | 2048 x 8 | (350ns) 5V Read/Write | 5.95 |
| 2817A | 2048 x 8 | (350ns) 5V Read/Write | 7.95 |
| 2865A | 8192 x 8 | (250ns) 5V Read/Write | 9.95 |
| 52B13 (21V) | 2048 x 8 | (350ns) 5V Read Only | 1.49 |

### COMMODORE CHIPS

| Part No. | Price |
|---|---|
| LAG570 | 10.95 |
| WD1770 | 11.95 |
| SI3052P | 2.49 |
| 6502 | 2.65 |
| 6504A | 1.95 |
| 6507 | 4.39 |
| 6510 | 9.95 |
| 6520 | 1.95 |
| 6522 | 3.95 |
| 6525 | 4.95 |
| 6526 | 14.95 |
| 6529 | 2.95 |
| 6532 | 6.49 |
| 6545-1 | 4.95 |
| 6551 | 4.49 |
| 6560 | 10.95 |
| 6567 | 14.95 |
| 6569 | 24.95 |
| 6572 | 8.95 |
| 6581 (12V) | 14.95 |
| 6582 (9V) | 14.95 |
| 8360 | 14.95 |
| 8501 | 10.95 |
| 8502 | 7.95 |
| 8563 | 15.95 |
| 8564 | 9.95 |
| 8566 | 24.95 |
| 8701 | 9.95 |
| 8721 | 14.95 |
| 8722 | 9.95 |
| *251104-04 | 10.95 |
| 310654-05 | 9.95 |
| 318018-03 | 10.95 |
| 318019-03 | 10.95 |
| 318020-04 | 10.95 |
| 325302-01 | 10.95 |
| 325572-01 | 14.95 |
| *82S100PLA** | 15.95 |
| 901225-01 | 11.95 |
| 901226-01 | 11.95 |
| 901227-03 | 11.95 |
| 901229-05 | 11.95 |

*No specs. available
**Note: 82S100PLA = U17 (C-64)

## SATELLITE TV DESCRAMBLER CHIP

The MM5321 is a TV camera sync generator designed to supply the basic sync functions for either color or monochrome 525 line/60Hz interfaced and camera video recorder applications. **COLOR BURST GATE & SYNC ALLOW STABLE COLOR OPERATION**

**MM5321N. . . . . $11.95**

***INTERSIL Also Available!***

## 74HC HI-SPEED CMOS

| Part No. | Price | Part No. | Price |
|---|---|---|---|
| 74HC00 | .25 | 74HC175 | .69 |
| 74HC02 | .25 | 74HC221 | 1.19 |
| 74HC04 | .29 | 74HC240 | .99 |
| 74HC08 | .29 | 74HC244 | .99 |
| 74HC10 | .29 | 74HC245 | .99 |
| 74HC14 | .49 | 74HC253 | .59 |
| 74HC30 | .29 | 74HC259 | .89 |
| 74HC32 | .29 | 74HC273 | .99 |
| 74HC74 | .39 | 74HC373 | .99 |
| 74HC75 | .39 | 74HC374 | .99 |
| 74HC76 | .45 | 74HC595 | 1.29 |
| 74HC85 | .79 | 74HC688 | .99 |
| 74HC86 | .39 | 74HC943 | 8.95 |
| 74HC123 | .89 | 74HC4040 | .99 |
| 74HC125 | .49 | 74HC4049 | .59 |
| 74HC132 | .69 | 74HC4050 | .59 |
| 74HC138 | .49 | 74HC4060 | .99 |
| 74HC139 | .49 | 74HC4511 | 1.29 |
| 74HC154 | 1.49 | 74HC4514 | 1.79 |
| 74HC163 | .65 | 74HC4538 | .89 |
| 74HC174 | .69 | 74HC4543 | 1.19 |

## 74HCT — CMOS TTL

| | | | |
|---|---|---|---|
| 74HCT00 | .29 | 74HCT139 | .59 |
| 74HCT02 | .29 | 74HCT157 | .69 |
| 74HCT04 | .29 | 74HCT174 | .69 |
| 74HCT08 | .29 | 74HCT175 | .69 |
| 74HCT10 | .29 | 74HCT240 | .99 |
| 74HCT32 | .29 | 74HCT244 | .99 |
| 74HCT74 | .49 | 74HCT245 | 1.19 |
| 74HCT86 | .49 | 74HCT373 | 1.19 |
| 74HCT138 | .59 | 74HCT374 | 1.19 |

## 74C—CMOS

| | | | |
|---|---|---|---|
| 74C00 | .29 | 74C174 | .79 |
| 74C02 | .29 | 74C175 | .79 |
| 74C04 | .29 | 74C221 | 1.79 |
| 74C08 | .35 | 74C240 | 1.79 |
| 74C10 | .35 | 74C244 | 1.79 |
| 74C14 | .59 | 74C373 | 1.99 |
| 74C32 | .35 | 74C374 | 1.99 |
| 74C74 | .59 | 74C912 | 8.99 |
| 74C85 | 1.49 | 74C915 | 1.39 |
| 74C86 | .35 | 74C920 | 6.99 |
| 74C89 | 5.49 | 74C921 | 6.99 |
| 74C90 | .99 | 74C922 | 3.99 |
| 74C154 | 2.95 | 74C923 | 3.99 |
| 74C173 | 1.05 | 74C925 | 5.99 |

## LINEAR

| | | | |
|---|---|---|---|
| DS0026CN | 1.95 | LM1458N | .39 |
| TL074CN | 1.19 | LM1488N | .49 |
| TL084CN | .99 | DS14C88N (CMOS) | 1.19 |
| AF100-1CN | 8.95 | LM1489N | .49 |
| LM307N | .45 | DS14C89N (CMOS) | 1.19 |
| LM309K | 1.25 | LM1496N | .89 |
| LM311N | .45 | MC1648P | 3.49 |
| LM317T | .79 | LM1871N | 1.99 |
| LM318N | .99 | LM1872N | 1.99 |
| LM319N | 1.29 | LM1896N-1 | 1.49 |
| LM323K | 3.95 | ULN2003A | .79 |
| LM324N | .39 | XR2206 | 3.99 |
| LM338K | 4.95 | XR2211 | 2.99 |
| LM339N | .39 | XR2243 | 1.99 |
| LF347N | 1.79 | 26LS29 | 3.99 |
| LM348N | .69 | 26LS31 | 1.19 |
| LM350T | 2.95 | 26LS32 | 1.19 |
| LF351N | .39 | 26LS33 | 1.49 |
| LF353N | .49 | LM2901N | .39 |
| LF355N | .79 | LM2907N | 1.29 |
| LF356N | .89 | LM2917N (8 pin) | 1.99 |
| LF357N | 1.09 | MC3419CL | 6.99 |
| LM358N | .49 | MC3446N | 1.69 |
| LM360N | 2.19 | MC3450P | 1.99 |
| LM361N | 1.79 | MC3470P | 1.99 |
| LM380N-8 | .99 | MC3471P | 1.99 |
| LM386N-3 | .89 | MC3479P | 4.79 |
| LM387N | .99 | MC3486P | 1.69 |
| LM393N | .39 | MC3487P | 1.69 |
| LM399H | 2.95 | LM3900N | .49 |
| LF411CN | .79 | LM3905N | 1.19 |
| TL497ACN | 1.49 | LM3909N | .99 |
| NE540H (C540H) | 2.95 | LM3914N | 1.99 |
| NE555V | .29 | LM3916N | 1.99 |
| XRL555 | .59 | NE5532 | .89 |
| LM556N | .49 | NE5534 | .89 |
| NE558N | .89 | 7805K (LM340K-5) | 1.29 |
| LM565N | .99 | 7812K (LM340K-12) | 1.29 |
| LM567V | .79 | 7815K (LM340K-15) | 1.29 |
| NE592N | .89 | 7805T (LM340T-5) | .49 |
| LM741CN | .29 | 7812T (LM340T-12) | .49 |
| LM747CN | .59 | 7815T (LM340T-15) | .49 |
| MC1350P | 1.09 | 7905K (LM320K-5) | 1.29 |
| MC1372P | 1.95 | 7905T (LM320T-5) | .99 |
| MC1377P | 2.29 | 75472 | .99 |
| MC1398P | 8.95 | 75477 | .99 |
| LM1414N | 1.29 | MC145106P | 3.29 |
| | | MC145406P | 2.99 |

## IC SOCKETS

| Low Profile | | Wire Wrap (Gold) Level |
|---|---|---|
| 8LP | .11 | 8WW |
| 14LP | .12 | 14WW |
| 16LP | .13 | 16WW |
| 24LP | .25 | 24WW |
| 28LP | .27 | 28WW |
| 40LP | .29 | 40WW |

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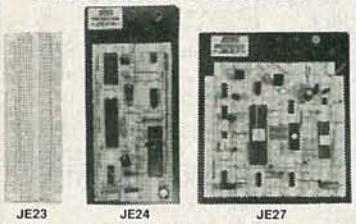
## PROTOTYPING PRODUCTS

### Jameco Solderless Breadboard Sockets



JE23 JE24 JE27

| Part No. | Dim. L" x W" | Contact Points | Binding Posts | Price |
|---|---|---|---|---|
| JE20 | 6½ x ¾ | 200 | 0 | $ 2.29 |
| JE21 | 3¼ x 2⅛ | 400 | 0 | $ 4.49 |
| JE22 | 6½ x 1⅜ | 630 | 0 | $ 5.95 |
| JE23 | 6½ x 2⅛ | 830 | 0 | $ 7.49 |
| JE24 | 6½ x 3⅛ | 1,360 | 2 | $14.95 |
| JE25 | 6½ x 4¼ | 1,660 | 3 | $22.95 |
| JE26 | 6⅞ x 5¾ | 2,390 | 4 | $27.95 |
| JE27 | 7¼ x 7½ | 3,220 | 4 | $37.95 |

### Jameco General Purpose Prototype PC Boards

JE417 (Pictured)

- Wire Wrap
- Component Testing
- Point-to-Point Wiring
- 31/62 Connection

JE415 (6½", No Pads, PC/XT). . . . . $14.95
JE417 (6½", Plated w/Pads, PC/XT). . . . $19.95

### Extender Board

JE421 (4¾" Extender, 31/62 Connector) . . $19.95

## DATA BOOKS

| | | |
|---|---|---|
| 30003 | National Linear Data Book (82). . . . . | $19.95 |
| 30005 | Logic Data Book - Vol. II (84). . . . . | $19.95 |
| 30009 | Intersil Data Book (87). . . . . | $14.95 |
| 21398 | CMOS Cookbook (86). . . . . | $14.95 |
| 210830 | Intel Memory Handbook (87). . . . . | $17.95 |
| 230843 | Intel Microsystem Hndbk. Set (87). . . . | $24.95 |

## MUFFIN/SPRITE-STYLE FANS

TA450S. . . . . $11.95
Torin Industries (4.68" sq., 50 cfm)

SU2A1. . . . . $11.95
EG&G Rotron (3.125" square, 34 cfm)

**NEW!** Switching Power Supply +5V@5A, +12V@1A x 2

• Regulated, 110VAC/220VAC Switchable • 40 watt • Size: 8½"L x 3"W x 2⅝"H • Weight: 1.1 lbs. • Data included

PSCC07. . . . . $14.95

### Jameco Computer Power Protection

JE1190

JE1190 Power Base. . . . . $29.95
JE1191 6-Outlet Power Strip . . . . $11.95
JE1192 300 Watt Back-Up. . . . $299.95
JE1193 500 Watt Back-Up. . . . $399.95

## IBM AND APPLE COMPATIBLE DISPLAY MONITORS

### Franklin 12" Green Monochrome

**Apple II, II+, *IIe*, *IIc* Compatible**

- Composite video output • 18MHz
- Resolution: 800 lines at center

SMON. . . . . $59.95

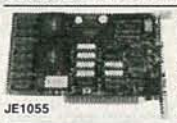
SMON

**12" Amber Monochrome —** TTL Input, High Resolution (PC/XT/AT)
AMBER. . . . . $109.95

**14" RGB Color —** CGA Compatible Amber/Green/Color Switchable, 640 x 200 Resolution (PC/XT/AT)
TTX1410. . . . . $279.95

**14" EGA Color -** EGA/CGA Compat., 720 x 350 (max.) resolution (PC/XT/AT)
TE5154. . . . . $399.95

**14" Ultrascan Color —** CGA/EGA/PGC/VGA Compatible, 800 x 560 (max.) Resolution (PC/XT/AT)
4375M. . . . . $579.95



JE1055

### IBM PC/XT/AT Compatible Cards

JE1050 Mono Graphics Card. . . . . $ 59.95
JE1052 Color Graphics Card. . . . . $ 49.95
JE1055 EGA Card. . . . . $149.95

## JAMECO COMPUTER KITS

**FREE! PC Write Word Processing Software Included!**

### Jameco's IBM™ AT Compatible Mini-286 6/8/10/12 MHz Kit!

| Part No. | Description | Price |
|---|---|---|
| JE1043 | 1.2M/360K Floppy Control . . | $ 49.95 |
| JE1015 | XT/AT Style Keyboard. . . . . | $ 59.95 |
| 41256-120 | 512K RAM (18 Chips) . . . | $ 71.10 |
| JE1012 | Baby AT Flip-Top Case. . . . . | $ 69.95 |
| JE1032 | 200W Power Supply. . . . . | $ 89.95 |
| JE1022 | 5¼" High Density Disk Drive . | $109.95 |
| JE1003 | Baby AT Motherboard (Zero-K RAM-incl. Award BIOS ROM) . . | $399.95 |

EGA Monitor TE5154 $399.95
EGA Card JE1055 $149.95 (not included)

***Reg. List $850.80***
***SAVE $50.85!***

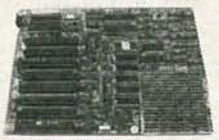
JE1008 IBM™ AT Compatible Kit. . . . . $799.95

### Jameco's 4.77/8MHz Turbo IBM PC/XT Compatible Kit

| | | |
|---|---|---|
| 4164-150 | 128K RAM (18 Chips). . | $ 22.50 |
| 41256-150 | 512K RAM (18 Chips). . | $ 58.50 |
| JE1010 | Flip-Top Case. . . . . | $ 34.95 |
| JE1015 | XT/AT Style Keyboard. . | $ 59.95 |
| JE1030 | 150 Watt Power Supply | $ 69.95 |
| JE1020 | 5¼" DSDD Disk Drive . . | $ 89.95 |
| AMBER | 12" Amber Monitor . . . | $109.95 |
| JE1001 | 4.77/8MHz Turbo Motherboard (Zero-K RAM – Includes Award BIOS ROM). . . . . | $104.95 |
| JE1071 | Multi I/O with Controller and Graphics. . . . . | $119.95 |

***Regular List $670.65***
***SAVE $70.70!***

JE1005 (IBM™ PC/XT Turbo Compatible Kit) . . $599.95



### Jameco's IBM PC/XT/AT Compatible Motherboards

• Award BIOS ROM included

JE1000 4.77MHz (PC/XT). . . . . $ 89.95
JE1001 4.77/8MHz (PC/XT). . . . $104.95
JE1003 6/8/10/12MHz (AT). . . . $399.95

***Additional Add-Ons Available!***

## COMPUTER PERIPHERALS

### Seagate 20, 30 & 40MB Half Height Hard Disk Drives

ST225K (Pictured)

| | | |
|---|---|---|
| ST225 | 20MB Drive only (PC/XT/AT) . . . | $269.95 |
| ST225K | 20MB w/Controller (PC/XT) . . . | $319.95 |
| ST238 | 30MB Drive only (PC/XT/AT) . . . | $299.95 |
| ST238K | 30MB w/Cont. (PC/XT/AT) . . . . | $339.95 |
| ST251 | 40MB Drive only (PC/XT/AT) . . . | $469.95 |
| ST251XT | 40MB w/Cont. Card (PC/XT) . . . | $549.95 |
| ST251AT | 40MB w/Cont. Card (AT). . . . . | $589.95 |

### Jameco PC/XT & AT Compatible Disk Drives

JE1022 (Pictured)

| | | |
|---|---|---|
| JE1020 | 360K Black Bzl. (PC/XT/AT). . . | $ 89.95 |
| JE1021 | 360K Beige Bzl. (PC/XT/AT). . . | $ 89.95 |
| JE1022 | 1.2MB Beige Bzl. (AT). . . . . | $109.95 |

### DATATRONICS 2400/1200/300 Modems

• Hayes command compatible • Bell 103/212A compatible • Auto-dial/auto-answer • FCC approved • 1-year warranty • The 1200H & 2400S include MaxiMite Communication Software • The 1200C & 2400E do not include software

| | | |
|---|---|---|
| 1200H | 1200/300 Baud Internal Modem. . . . | $ 79.95 |
| 2400S | 2400/1200/300 Internal Modem. . . . | $174.95 |
| 1200C | 1200/300 Baud External Modem. . . . | $119.95 |
| 2400E | 2400/1200/300 External Modem . . . . | $219.95 |

### Jameco Extended 80-Column Card for Apple *IIe*

• 80 Col./64K RAM • Doubles amount of data your Apple *IIe* can display as well as its memory capacity • Ideal for word processing • Complete with instructions

JE864 $49.95

ADD12 (Disk Drive II, II+, *IIe*) $99.95

***Additional Apple Compatible Products Available***

### ZUCKERBOARD TANDY 1000 Expansion Memory Half Card

Expand the memory of your Tandy 1000 (128K Version) to as much as 640K. Also includes DMA controller chip.

| | | |
|---|---|---|
| TE512 | Includes 512K RAM. . . . . | $119.95 |
| TANC | Plug-in Clock option chip (only) . . . | $39.95 |

### 20Meg Hard Disk for Tandy 1000/SX

| | | |
|---|---|---|
| T20MB | 20MB Hard Disk Drive Board for Tandy 1000. . . . . | $494.95 |
| SX20MB | 20MB Hard Disk Drive Board for Tandy 1000SX. . . . . | $499.95 |

### Accessories for Commodore VIC-20, C-64 & C-128

JE232CM (Pictured)

| | | |
|---|---|---|
| JE232CM | (RS232 Inter. VIC-20, C-64 and C-128 in 64 mode) . . . . | $39.95 |
| CPS10 | (C-64 Power Supply). . . . . | $39.95 |
| CPS128 | (C-128 Power Supply). . . . | $59.95 |

U.S. Funds Only
Shipping: Add 5% plus $1.50 Insurance
(May vary according to weight)

California Residents: Add 6%, 6½% or 7% Sales Tax

*FAX 415-592-2503*

2/88

$20 Minimum Order

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# AMERICAN DESIGN COMPONENTS?

We warehouse 60,000 items at American Design Components – expensive, often hard-to-find components for sale at a fraction of their original cost!

You'll find every part you need – either brand new, or removed from equipment (RFE) in excellent condition. But quantities are limited. Order from this ad, or visit our retail showroom and find exactly what you need from the thousands of items on display.

*OPEN MON. – SAT., 9–5*

**THERE'S NO RISK.**
With our full 90-day warranty, any purchase can be returned for any reason for full credit or refund.

## *ADAM* COMPUTER

***(Less printer)***
No wiring necessary (just plugs together). Hook-up diagram included. Includes: Keyboard, 1 cassette digital data drive, 2 game controllers, power supply, & one cassette. Capable of running CP/M, has built-in word processor.
Item #7410 Complete – **$99.00**

## *ADAM* 5¼" DISK DRIVE

Gives your Adam fast, reliable data storage and retrieval. Can hold up to 160K bytes of information. Uses industry-standard SS/DD disks. Connects directly to your Adam memory console. Comes with disk drive power supply, Disk Manager disk and owner's manual.
Mfr – Coleco, model 7817. Item #12830
***Like New*** – **$199.00**

## 15 Mb 5¼" FULL HT. DISK DRIVE

**(IBM® PC/XT Compatible)**
Removed from working equipment. Tested & formatted.
Mfr – CMI model CM5619
Item #14511 **$199.00**

## 10 Mb 5¼", HALF HT. DISK DRIVE

**(IBM® Compatible)**
Shock mounted, high speed, low power. Mfr – Tandon TM252
Item #13250 **$159.00**
**Controller Card** for above
Item #10150 **$89.00**

## 5¼" FULL HEIGHT DISK DRIVES –

**48 TPI (IBM® Compatible) DS/DD, 80 Track**
Tandon #TM100-2 or equiv.
Item #7928 **$79.00** New
2 for **$150.00** New

**48 TPI (TRS80/Zenith/Xerox 800 Compat.) DS/DD, 40 Track**
Shugart #450. Item #1892.
**$79.00;** 2 for **$150.00**

**48 TPI, SS/DD, 40 Track**
Shugart #SA400. Item #1895.
**$39.50;** 2 for **$75.00**

**96 TPI, DS/Quad Density**
CDC #9409T
Item #1893 **$89.00**

## 5¼" 1/2 HT. DISK DRIVES

**IBM® AT Compatible)**
**48/96 TPI, 1.2 Mb**
Double side, high density; 160 tracks. Mfr – Panasonic #JU-475
Item #10005 **$109.95** New
**96TPI, (DOS 3.2 Compat.**
Double side, quad density.
Mfr – Tandon TM55–4
Item #1904 **$79.00**
2 for **$150.00**

## MAGNIFYING LAMP

Multi position, 30", completely adjustable swing arm w/3-way metal C-clamp. Has 4" diopter magnifying lens, w/ruler. Porcelain lamp socket, & on/off switch; uses up to a 60W bulb. Color: Beige. UL listed.
Item #13136 **$24.95** New

## *Protect your Printer/ Typewriter with our* DIABLO CLEANING KIT

For printers & typewriters w/print wheel, spindle, & metal ball type print elements. Good for 5 cleanings. Incl.: platen cleaner, type/print element cleaner, sound shield cleaner, plus buffers & cloths.
Mfr – Diablo Supplies #9R87106
Item #15419
3 sets/**$14.95** New

## 5¼" FLOPPY DISKETTES

Single side/single density; 16 hard sectors. Mfr – Xerox #11R61630
Item #14537
Pack of 10 **$9.95** New

## MICROCOMPUTERS with EPROM

**MC68701**

The **MC68701** is an 8-bit single chip microcomputer unit that enhances the capabilities of the M6800 family. TTL compatible, requires one +5V power supply for nonprog. operation. Includes 2048 bytes of eprom, 128 bytes of RAM, serial comm. interface (SCI), parallel I/O, and a 3-function programmable timer. Item #9496
**$9.95** (house numbered)

**MC68705**

**MC68705** – HMOS, 8-bit, medium performance microcomputer. On-chip resources: 3776 bytes Eprom, 112 bytes RAM. 8 inputs & 24 programmable bidirectional outputs. Self programming boot strap.
Item #13608 **$9.95**

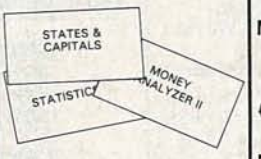
## 115 VAC 27 CFM MINI FANS

50/60Hz.; 12W. Low noise level fans, can be mounted for blowing or exhaust.
**1" Thin:** contains 9 plastic blades
Dim.: 3⅛" sq. x 1" deep
Mfr – Tobishi #U9201B
Item #10960 **$7.95** RFE
**1½" Standard:** contains 7 metal blades.
Mfr – Rotron #SU2A1
Item #5970 **$7.95** New

## 150 CFM SUPER VENTURI FAN

Ball bearing; 115 VAC, 60 Hz.; .195/.178 amps. Has 2 sets of mtg. holes (fits standard rack or larger). Can be mtd. for blowing or exhaust. Dim.: 5" sq. x 1½" deep.
Mfr – Rotron
Item #1866 **$19.95** New

## TIMEX-SINCLAIR 1000 & ZX-81 CASSETTES




Consists of 13 assorted cassettes. May include: ***Money Analyzer II, States & Capitals, Casino Craps, Statistics, The Carpooler & others.***
Item #14651
Set of 13 **$19.95** New

**Complete line of Computer & Game Equipment!**
***Please call or write with your requirements.***

## *ADAM Accessories . . .*

***Adam Printer*** – Item #8839 **$69.50**
**Data Drive** – Item #6641 **$19.95**
**Printer Power Supply** – Item #6642 **$14.95**
**ASCII Keyboard** – Item #6643 **$19.95**
**Controllers – (Set of 4)** Item #7013 **$9.95** Used
***Adam* Cassettes** – (Consisting of Smart Basic, Buck Rogers & blank cassette.) Item #7786
***BAKER'S DOZEN*** – **$19.95**
***Adam* Link Modem** – **(Software included.)** Item #12358 **$29.95**
**Auto-Dialer Address Book** – Item #12365 **$19.95**
***Adam* Daisy Print Wheel** – Item #13305 **$3.95**
***Adam* Ribbon Cartridge** – Item #13306 **$3.95**
**Disk Drive Power Supply** – Item #14603 **$14.95**
***ColecoVision* to *Adam* Expansion Kit** Item #9918 **$59.50**
**Expansion Module #2** – (w/*Turbo* cartridge.) Item #*13146* ***$39.95*** New
**Roller Controller** (w/*Slither* cartridge) Item #13147 **$39.95** New
**Super Action Controller Set** – (w/*Baseball* cartridge.) Item #13148 **$39.95** New

## 115 CFM MUFFIN® FANS

115VAC/60Hz.; 21W.; 28A.; 3100 RPM; 5-blade model; aluminum housing. Can be mtd. for blowing or exhaust.
Dim.: 4¹¹⁄₁₆"sq. x 1½" deep
**NEW** – Mfr: IMC Item #1864 **$12.95**
**USED** – Mfr: Centaur/Howard Item #5345 **$5.95**

## STEPPING MOTORS for ROBOTICS . . .

***Precision steppers with increments from 1 to 7.5 degrees. Speeds up to 5,000 steps.***

Fig. 1

Fig. 2

| Item No. | Step Angle | Volts DC | Stall Torque oz/in | Type | Mfr. & Part No. | Fig | Price |
|---|---|---|---|---|---|---|---|
| 5431 | 1 | 5 | 17 | PM | N.A. Phillips A82310-M2 | 1<br>2/ | $9.95 ea.<br>$14.95 |
| 5275 | 1.8 | 1.8 | 72 | PM | Superior Electric 2 Ø MO61-FF-6201B | 2<br>2/ | $19.95 ea.<br>$37.50 |
| 7630 | 1.8 | 3.0 | 200 | PM | Superior Electric M092-FT-402 | 2<br>2/ | $34.50 ea.<br>$59.50 |

## — BATTERIES — — CASSETTES —

## NEON TRANSFORMER (Hi-Voltage)

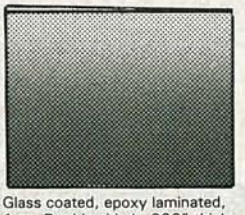
**7300 VAC @ 5 Ma.**
May be used for powering neon lights, replacing oil burner ignition transformer, building Jacob's ladder (spark gap). A high-volt. output: ¼ quick connect terminal & case ground input fully enclosed metal case. Weight: 12 lbs. Base mount: 4½"H x 5⅛"W x 6⅞"
Item #151 **$9.95** RFE

## MINI MICRO-COMPUTER REGULATOR

**140 VA**

Provides voltage regulation & ultra-isolation for microprocessor-based equipment. Contains less than 3% harmonic distortion, better than 60 dB traverse noise rejection. Contains dual outlet for CPU & monitor, & 6 ft. line cord.
Input: 95 – 130V, 60Hz.
Output: 120V @ 1.17A
Dimen.: 11⅝"L x 4⅜"H x 5⅝"W
Mtd on metal base w/rubber ft.
Mfr – Sola #63-13-114
Item #9999 **$99.00** New

## COPPER-CLAD PRINTED CIRCUIT BOARD *(Double-sided)*



Glass coated, epoxy laminated, 1 oz. Double sided, .022" thick. Dimensions: 24"L x 18.5"H
Item #13606
3 sheets/**$9.95**

## RECORDING TAPE 7½" Reel, 2400 ft.

Bulk erased. Major mfrs.: Ampex, Scotch, etc.
Item #6711 – ¼ Mil.
15 reels for **$9.95**

## JOYSTICK CONTROLLERS

Fits Atari, Apple, Commodore, and our Item #10336 PC8300 Computer. Has 4-ft. cord w/plug. Dimen.: 3½"sq. x 1½" H.
Item #12143 **$5.95** New



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## 14" EGA COLOR MONITOR
**PC, XT, & AT Compatible**

Perfect for text, CAD, & other graphics applications. Scanning frequency to 25KHz. Resolution: 720 x 350 max. Input: 110/220V, 50/60Hz., 80W. (Hook-up diagram incl.) Mtd. in metal housing. Mfr. #14-GZF2

Item #14864 **$179.00** New

## 5" COMPOSITE VIDEO MONITOR

12 VDC. Power regulated. Mounted in plastic cabinet, with brightness control knob. Dim.: 8"W x 8"H x 8¾"deep Mfr — Sperry

Item #14536 **$24.95**

## EXTERNAL DISK DRIVE CHASSIS

With 60W power supply (fan cooled). Can accommodate:
2 full ht. drives our item #7928
2 floppy drives #1904
1 hard drive & 1 floppy #13250
Input: 115/230V, 50/60 Hz. Originally for Burroughs computer. Dim.: 11"W x 8"H x 12" deep

Item #14541 **$59.50**

## PC 8300 HOME COMPUTER
**(Advanced version of the Timex 1000)**

42-key mech. keybd. 2K RAM. Rev. video, Z80A, 6.5MHz processor, ROM 8K BASIC. Graphics cap./sound–music, TV or monitor. Joystick input. 115 VAC. AC adapt., TV cable, & cass. cables. Runs tapes for Sinclair/Timex 1000-ZX85. Mfr - Power 3000. (In orig. boxes.)

Item #10336 **$29.95** New

★ **16K RAMPACK upgrade**

Item #10337 **$9.95** New

## 12", HIGH RES. TTL MONITOR

12 VDC/110 VAC (w/built-in power supply). Green phosphor. Mtd. in metal housing. Schematic supplied. Mfr — Capetronic #DS-1030;

Item #6811 **$19.95** New

## COMPUTER GRADE POWER SUPPLY

***Other uses–runs CB & car radios. Comes ready to plug in!***
DC Output: –5V @ .5 amp.
+5V @ 3 amp.
+12V @ 6 amp.
Input 115V/60Hz. Dim.: 9¼"W x 3¾"H. (Rubber ft. incl.)

Item #9501 **$24.95** New

## *COMMODORE* CARTRIDGES

### C-64
Consists of 8 asstd. cartridges, incl.: ***Number Nabber, Star Post, Radar Rat, Jupiter Land, Viduzzles, Golf, Dragon's Den,*** & ***ABC Voice.***
Item #13573
Set of 8 — **$39.95** New

### C16 & +4
Consists of 8 asstd. cartridges, incl.: ***Calc Plus, Script+, Jack Attack, Pirate Adventures, Atomic Miss, Strange Odyssey, Financial Advisor,*** & ***Logo.***
Item #13572
Set of 8 — **$29.95** New

## COMMODORE VIC 20 CPU BOARD

Insides of the Commodore VIC 20. For parts only — guaranteed not to work!

Item #12144 **$14.95**

## *COMMODORE/AMIGA* POWER SUPPLY

DC Output: +5V @ 8 amps.
+12V @ 1 amp.
–5V @ 250 ma.
Input: 110VAC/60 Hz., ±20%
Dim.: 12"L x 3¾"H x 5¾"D
Encl. in alum. housing. Fan cooled.
Mfr — Shindenger Electric #130569SXD

Item #14047 **$19.95** New

## *INTEGRATED CIRCUITS . . .*

### STATIC RAMS

| | | | | | |
|---|---|---|---|---|---|
| 2114-45 | 1024×4 (450ns) | $ .99 | HM6116LP-3 | 2048×8 (150ns) | $1.89 |
| 2148-55 | | 3.49 | HM6116LP-4 | 2048×8 (200ns) | 1.85 |
| 2149 | 1024×4 (45ns) | 2.49 | 6147P | | 2.95 |
| 2167S-45 | | 3.95 | 6167P-6 | | 4.50 |

### DYNAMIC RAMS

| | | | | | |
|---|---|---|---|---|---|
| 4116-200 | 16,384×1 (200ns) | $ .69 | TMS4416 | 16,384×4 (150ns) | $3.75 |
| 4116-250 | 16,384×1 (250ns) | .49 | 4464-150 | 65,536×4 (150ns) | 4.95 |
| 4164-150 | 65,536×1 (150ns) | 1.25 | 8118 | 16,384×1 (120ns) | .49 |
| TMS4164 | 65,536×1 (150ns) | 1.95 | 41256-150 | 262,144×1 (150ns) | 2.95 |

### EPROMS

| | | | | | |
|---|---|---|---|---|---|
| 2708 | 1024×8 (450ns) | $4.95 | 2764-250 | 8192×8 (250ns) | $3.55 |
| 2716 | 2048×8 (450ns) | 3.49 | MCM68766 | 8192×8 (350ns) | 15.95 |
| TMS2532 | 4096×8 (450ns) | 5.95 | 27128A-25 | 16,384×8 (250ns) | 5.00 |
| 2732 | 4096×8 (450ns) | 3.95 | 27128-250 | 16,384×8 (250ns) | 4.25 |
| 2732A-25 | 4096×8 (250ns) | 3.95 | 27C256 | 32,768×8 (250ns) | 7.95 |
| 27C64 | 8192×8 (250ns) | 4.95 | 27256 | 32,768×8 (250ns) | 5.95 |
| 2764 | 8192×8 (450ns) | 2.95 | 27512 | 65,536×8 (250ns) | 11.55 |
| 2764A-25 | 8192×8 (250ns) | 3.55 | | | |

### LINEAR

| | | | | | |
|---|---|---|---|---|---|
| LH0002CN | $5.35 | TL497ACN | $1.97 | 7818K | $1.21 |
| LM10CLH | 2.65 | NE555V | .26 | 7824K | 1.21 |
| LH0070-OH | 3.55 | XR-L555 | .62 | 7805T | .44 |
| TL071CP | .53 | LM556N | .53 | 7812T | .44 |
| TL072CP | .71 | NE558N | 1.07 | 7815T | .44 |
| LM301N | .32 | NE564N | 1.75 | 7818T | .44 |
| LM307N | .41 | LM565N | .90 | 7824T | .44 |
| LM310N | 1.16 | LM566CN | 1.25 | 78S40 | 1.75 |
| LM311N | .41 | LM567V | .80 | 7905K | 1.21 |
| LM317K | 2.65 | NE570N | 2.24 | 7906K | 1.21 |
| LM317LZ | .62 | NE571N | 1.75 | 7912K | 1.21 |
| LM317MP | .80 | NE592N | .80 | 7915K | 1.21 |
| LM317T | .90 | LM748CN | .53 | 7918K | 1.21 |
| LM318N | 1.07 | DS8T28N | 1.57 | 7924K | 1.21 |
| LM319N | 1.07 | LM1456V | 1.75 | 7905T | .53 |
| LM324N | .35 | LM1458N | .44 | 7912T | .53 |
| LM334Z | 1.07 | LM1488N | .62 | 7915T | .53 |
| LM336Z | .98 | LM1496N | .90 | 7918T | .53 |
| LM337MP | 1.03 | LM1899N | 1.43 | 7924T | .53 |
| LM337T | 1.34 | ULN2003A | .90 | 79L12AC | .53 |
| LM338K | 3.55 | DS26LS31CN | 1.34 | 79L15AC | .53 |
| LM339N | .44 | DS26LS32CN | 1.34 | LF13201N | 2.33 |
| LF347N | .90 | LM2901N | .53 | LM13600N | 1.07 |
| LM348N | .62 | LM2903N | .53 | LM1889 | 1.85 |
| LM350K | 3.55 | LM2907N | 1.75 | 75107N | .90 |
| LF353N | .53 | LM2917N | 1.39 | 75108N | .90 |
| LF356N | .80 | LM2917-14N | 1.34 | 75110A | 1.34 |
| LM358N | .44 | LM2931CT | 1.07 | 75115 | 1.07 |
| LM380N | .80 | MC3346P | .90 | 75123N | 1.34 |
| LM380N-8 | .98 | MC3486 | 1.34 | 75124N | 1.34 |
| LM381N | 1.16 | MC3487 | 1.34 | 75138N | 2.65 |
| LM383T | 1.34 | SG3524 | 1.75 | 75154N | 1.25 |
| LM385Z | 1.70 | LM3900N | .53 | 75450N | .53 |
| LM386N-4 | .80 | LM3914N | 1.75 | 75451CN | .44 |
| LM389N | .90 | RC4136N | .80 | 75452CN | .44 |
| LM393N | .41 | RC4151NB | .90 | 75453CN | .44 |
| LF398N | 2.15 | RC4193NB(DE) | 2.65 | 75463N | .53 |
| LF411CN | .71 | 7805K | 1.21 | 75472 | .80 |
| TL494CN | 1.75 | 7812K | 1.21 | 75492N | .71 |
| TL496CP | 1.34 | 7815K | 1.21 | 76477 | 3.55 |

**— KEYBOARDS — DISK DRIVES — POWER SUPPLIES — VOLTAGE REGULATORS —**
**— MICROCOMPUTERS — MONITORS — POTENTIOMETERS — CIRCUIT BOARDS —**

## 12V BATTERY PACK & CHARGER 12V @ 9.5Ah

Consists of: 2 solid gell cell batteries, 6V @ 9.5Ah ea. Connected in series by a fusable harness. Mating battery charger: 12VDC @ 800Ma. Perfect for battery-operated toys, robotics, solar storage, burglar & fire alarms, etc. OA Dim.: 4¼"W x 5½"H x 5½"D

Item #14619 **$29.95** New

## NICAD BATTERIES (Rechargeable)

**12V @ 450 ma**
Contains 10 AA cells. Recharge rate: 45 ma. 16–18 hours. Dim.: 2 1/16"H x 1¼"W x 2 15/16"L Mfr — GE 123233 or equiv.

Item #5443 **$5.95** New

## "D" CELLS

**Dual Pack 2.4V @ 1.2Ah**
2 D cells, stacked & series connected (easily ganged for carrying). Recharge in 12-14 hrs. OA Dim.: 1½" dia. x 4½"L

Item #12142 (pack of 2) **$5.95**
(Major mfrs.) 5 packs/**$25.00**

## GELL CELL/LEAD ACID BATTERIES . . .

RECHARGEABLE — Used for solar energy storage, alarm systems, remote control boats, robots, etc.

**12V @ 4.5AH**
Dim.: 6"L x 3⅝"H x 2½"D
Mfr — EPC #0027

Item #13325 **$7.95**

**6V @ 9.5AH**
Dim.: 5½"H x 4⅛"W x 2⅝"D
Mfr — Elpower #695

Item #7039 **$14.95**

## CRYSTALS $1.75 ea.
**(Microprocessor) HC-18U**

| Mhz. | Item # |
|---|---|
| 1.8432 | 7915 |
| 3.2768 | 13911 |
| 3.579545 | 12361 |
| 4.0 | 7045 |
| 4.032 | 13041 |
| 5.0 | 13043 |
| 5.0688 | 6786 |
| 6.0 | 12362 |
| 6.144 | 13226 |
| 10.736835 | 1953 |
| 12.0 | 7920 |
| 13.7931 | 7362 |
| 14.31818 | 7359 |
| 16.0 | 13425 |
| 18.432 | 13227 |
| 20.0 | 12360 |
| 48.0 | 7389 |
| 122.666 | 7037 |

## ANALOG to DIGITAL CONVERTER

Binary output: 12 bit; Conversion time: 8 microseconds; Linearity: 8 ms. ±1/2 lbs. Parallel and series outputs; internal reference. Mfr — Datel ADC-HZ-12BGC

Item #7052 (RFE—tested good!)
Originally ~~$130.00~~
Special — **$39.95**

## COMPUTER/COPIER — SUPPLIES CART/STAND

Metal cabinet w/wood finish formica top. On 2" swivel casters. Has 2 sliding doors & 2 inside shelves. Easily assembled. OA Dim.: 32"H x 30"W x 18"deep Cabinet Dim.: 20½"H x 30"W x 18"deep Weight: 63 lb.

Item #14538 **$49.95** New

**AMERICAN DESIGN COMPONENTS,** 62 JOSEPH STREET, MOONACHIE, N.J. 07074

**YES!** Please send me the following items:

| Item No. | How Many? | Description | Price | Total |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Total
Shipping & handling, we ship UPS unless otherwise specified. Add $3 plus 10% total. Canadian: $3 plus P.O. cost. Charge only.
Sales Tax (N.J. residents only, please add 6% of total)
ORDER TOTAL

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☐ Charge my credit card.
☐ Visa ☐ Master Card ☐ Amex

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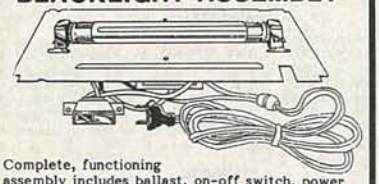
# ALL ELECTRONICS CORP.

ALL ELECTRONICS CORP.

## BLACKLIGHT ASSEMBLY

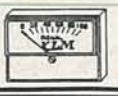


Complete, functioning assembly includes ballast, on-off switch, power cord, sockets and F4T5-BL blacklight. Mounted on a 7 1/8" X 3 1/8" metal plate. Use for special effects lighting or erasing EPROMS.

CAT# BLTA $10.00 EACH

## 1mA METER

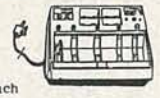
Modutec 0-1 mA signal strength meter with KLM logo. 1/4" X 1 3/4" X 7/8" deep.



CAT# MET-2 $2.00 each

## NI-CAD CHARGER/TESTER

DELUXE universal charger and tester for almost every size Ni-cad battery available.



CAT# UNCC-N $15.00 each

## RECHARGEABLE NI-CAD BATTERIES

| | |
|---|---|
| AAA SIZE 1.25V 180mAH | $2.25 |
| AA SIZE 1.25V 500mAH | $2.00 |
| AA with solder tabs | $2.20 |
| C SIZE 1.2V 1200mAH | $4.25 |
| SUB-C SIZE solder tab | $4.25 |
| D SIZE 1.2V 1200mAH | $4.25 |

## COMPUTER GRADE CAPACITORS

**1,400 MFD 200 VDC**
2" dia. X 3" high
CAT# CG-1420 $2.00

**7,500 MFD 200 VDC**
3" dia. X 4 3/4" h.
CAT# CG-75 $4.00

**22,000 MFD 25 VDC**
2" dia. X 4 3/4" h.
CAT# CG-22 $2.50

**72,000 MFD 15 VDC**
2" dia. X 4 3/8" h.
CAT# CG-130 $3.50

## TRANSISTORS

**2N2222A**
3 for $1.00

**PN2222A**
4 for $1.00

**2N2904**
3 for $1.00

**2N2905**
3 for $1.00

**2N3055**
$1.00 each

**PN3569**
10 for $1.00

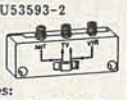
## WALL TRANSFORMER

11.5 Vdc
1.95 AMP.
Input:
120 Vac

SIZE: 3 3/4" X 2 7/8" X 2 5/8"
CAT# DCTX-11519
$6.50 each

## A/B SWITCH

JVC# PU53593-2
High quality A/B switch.
Measures: 3 3/4" X 1 7/16" X 1". 75 OHMS IN/OUT
CAT# ABS-2 $3.50 each



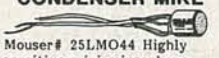
## 13.8 VDC REGULATED POWER SUPPLY

Solid state, fully regulated 13.8 Vdc power supplies. Both feature 100% solid state construction, fuse protection and LED power indicator. UL listed.

2 AMP CONSTANT, 4 AMP SURGE
CAT# DVP-412 $22.50 each

3 AMP CONSTANT, 5 AMP SURGE
CAT# DVP-512 $30.00 each

## ELECTRET CONDENSER MIKE



Mouser# 25LMO44 Highly sensitive mini microphone. 6" wire leads. 0.39" dai. X 0.27" high. Omni directional. Operates on 2-10 Vdc @ less than 1 mA. 1K impedance. 50 to 8 K Hz range.
CAT# MKE-1 $1.00 EACH

## SLIM LINE FAN

TOYO# TF92115A New 115 Vac cooling fan. 3 5/8" square X 1" deep. Metal housing. 5 blade impeller.

CAT# SCFE-115 $8.50 each
10 for $75.00

## 2K 10 TURN

Multi-turn pot
Spectrol# MOD 534-7161
CAT# MTP-10-2
$5.00 each

## VENTED PROJECT CASE

Bopla #BO 718L Vented top and bottom. Black plastic with removable end panels. 9" X 8 1/2" X #"
CAT# MB-718 $12.50 each

## 6-12 VDC MOTOR

Mabuchi # RS-550S
Permanent magnet motor.
1 7/16" dia X 2 1/4" long
2,600 RPM @ 6 Vdc-200 mA
5,300 RPM @ 12 Vdc
CAT# DCM-7 $3.00 each

## LED'S

Standard Jumbo Diffused T 1-3/4 Size

| | | |
|---|---|---|
| RED | CAT# LED-1 | 10 for $1.50<br>100 for $13.00<br>1000 for $110.00 |
| GREEN | CAT# LED-2 | 10 for $2.00<br>100 for $17.00<br>1000 for $150.00 |
| YELLOW | CAT# LED-3 | 10 for $2.00<br>100 for $17.00<br>1000 for $150.00 |

## FLASHING LED

w/ built in flashing circuit operates on 5 Volts...
RED $1.00 each
CAT# LED-4 10 for $9.50
GREEN $1.00 each
CAT# LED-4G 10 for $9.50

## BI-POLAR LED

Lights RED one direction, GREEN the other. two leads.
CAT# LED-6 2 for $1.70

## LED HOLDERS

Two piece holder.

CAT# HLED 10 for 65c

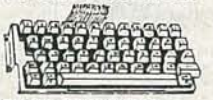
## CLIPLITE LED HOLDER

Makes L.E.D. look like a fancy indicator

| | |
|---|---|
| CLEAR | CAT# HLDCL-C |
| RED | CAT# HLDCL-R |
| GREEN | CAT# HLDCL-G |
| YELLOW | CAT# HLDCL-Y |

4 of one color $1.00

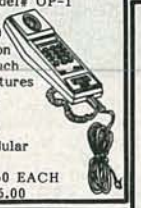
## 48 KEY ASSEMBLY



NEW T.I. KEYBOARDS. Originally used on computers, these keyboards contain 48 S.P.S.T. mechanical switches. Terminates to 15 pin connector. Frame 4" X 9"
CAT# KP-48 $3.50 each

## PUSHBUTTON PHONE

Spectra-phone Model# OP-1 1 piece telephone with rotary (pulse) output. Operates on most rotary or touch tone systems. Features last minute redial and mute button. Includes coil cord with standard modular plug. IVORY.



CAT# PHN-1 $8.50 EACH
2 FOR $15.00

## RELAYS

### 12 VDC-4PDT

P.C. mount
5 amp contacts
150 ohm coil
Size: 1 1/4" X 1 3/4" X 7/8"

CAT# 4PRLY-12PC $3.50
10 for $30.00

### 10AMP SOLID STATE

Control: 3-32 Vdc
Load: 10 AMPS, 120 Vac
Size: 2 1/2" X 3/4" X 7/8"

CAT# SSRLY-10A $9.50
10 for $85.00

### 25 AMP SOLID STATE

OPTO 22# 240D25
TTL compatable.
INPUT: 3-32 VDC
OUTPUT: 25 AMPS @ 240 VAC
SIZE: 2 1/2" X 3/4" X 7/8"

CAT# SSRLY-2524 $15.00 each

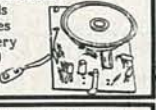
## THIRD TAIL LIGHT

Sleek high-tech lamp assembly. Red lens is 2 3/4" X 5 1/2" mounted on a 4" high pedestal with up-down swivel adjustment. Has 12V replaceable bulb.

CAT# TLB $3.95 each

## SOUND EFFECTS BOARD

P.C board with 2 1/4" speaker, 2 LEDs, IC, battery snap, other components 2 3/8" X 3". When switch is pushed board beeps and leds light. Operates on a 9V battery (not included)

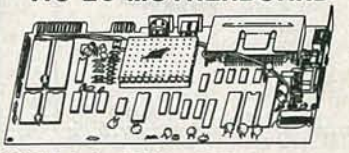


CAT# ST-3 $1.25 each

## XENON FLASH TUBE

3/4" long X 1/8" dia.
CAT# FLT-1 2 for $1.00

## VIC 20 MOTHERBOARD



26 IC's including 6502A and 6560. 2 ea. 6522, 2 ea. 8128, 2 ea. 901486, 3 ea. 2114. Not guaranteed but great for replacement parts or experimentation.
CAT # VIC-20 $15.00 each

## SWITCHING POWER SUPPLY

Compact, well regulated switching power supply designed to power Texas Instruments computer equipment.
INPUT: 14-25 vac @ 1 amp
OUTPUT: +12 vdc @ 350 ma.
+5 vdc @ 1.2 amp
-5 vdc @ 200 ma.
SIZE: 4 3/4" square.
Includes 18 Vac @ 1 amp wall transformer designed to power this supply.

CAT# PS-TX $5.00 / set
10 for $45.00

## LIGHT ACTIVATED MOTION SENSOR

This device contains a photocell which senses sudden change in ambient light. Could be used as a door anunciator or modified to trigger other devices. 5 1/2" X 4" X 1". Operates on 6 Vdc. Requires 4 AA batteries (not included).

CAT# LSMD $5.75 per unit

## TRANSFORMERS

**5.6 VOLT- 750ma**
CAT# TX-56 $3.00

**12 V.c.t.-1amp**
CAT# TX-121 $4.00

**12 V.c.t.-2amp**
CAT# TX-122 $4.85

**12 V.c.t.-4amp**
CAT# TX-124 $7.00

**18 VOLT-650ma**
CAT# TX-186 $2.00
10 for $18.00

**24 V.c.t.-1amp**
CAT# TX-241 $4.85

**24 V.c.t.-2amp**
CAT# TX-242 $6.75

**24 V.c.t.-3amp**
CAT# TX-243 $9.50

**24 V.c.t.-4amp**
CAT# TX-244 $11.00

## SWITCHES

MINIATURE TOGGLE SWITCHES rated 5 Amps

**S.P.D.T. (ON-ON)**
Non threaded brushing P.C. mount.
CAT# MTS-40PC 75c each
10 for $7.00

**S.P.D.T. (ON-ON)**
Solder lug terminals.
CAT# MTS-4 $1.00 each
10 for $9.00

**D.P.D.T. (ON-ON)**
Solder lug terminals.
CAT# MTS-8 $2.00 each
10 for $19.00

**MINI PUSH BUTTON**
S.P.S.T. momentary. Push to make 1/4" brushing. Red button.
CAT# MPB-1 35c each
10 for $3.00

## POLARITY SWITCH

Designed to control an external coaxial relay on a satellite t.v. system. Ideal for parts. Contains a 5 Vdc relay and many other parts on a P.C. board.

CAT# RPDS $1.75 each 10 for $15.00

## SOUND AND VIDEO MODULATOR

TI# UM1381-1. Designed for use with T.I. computers. Can be used with video cameras, games or other audio/video sources. Built in A/B switch enables user to switch from T.V. antenna without disconnection. Operates on channel 3 or 4. Requires 12 Vdc. Hook up diagram included.

CAT# AVMOD $5.00 each

## TELEPHONE COUPLING TRANSFORMER

STANCOR
# TTCP-8

600 ohms c.t. to 600 ohms c.t.
P.C. board mount.
3/4" X 5/8" X 3/4"

CAT# TCTX8
$2.50 each

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## DIGITAL MENO TA-28 △

NEW FOR 1988

SPECIFICATIONS:
16 SEC. RECORD TIME * LED FUNCTION INDICATOR * AUTO RECORD CIRCUIT * INTERNAL 256K DRAM MEMORY * INTERNAL MIC AMPLIFIER * ONE PUSH ON/OFF POWER * TWO RECORD FUNCTION TALK-BACK MODE & MESSAGE MODE * LOW POWER CONSUMPTION * SUPPLY VOLTAGE: 9V 20MA D. C.
KIT .....$20.00

## STATE OF ARTS HQ FET ST. PRE - AMP

TA - 377A △△

0.007% T.H.D

- This Pre-amplifier employs 18 pairs of HIGH QUALITY N channel and P channel FET and 1% metal film resistor to form a state of arts full complementary symmetric mirror circuit.
- It uses "CR" RIAA EQ pre-amplifier to minimize TIM distortion and to obtain high-fidelity.
- The power supply is based on by pass coupling DC stabilizer which uses class A design to obtain low internal impedance at high frequency and to greatly reduce transient distortion.
- Professional relay delay circuit prevents noise which may occur during power on and off.
- All FETs were tested and paired in the factory so no problem is likely to occured during building.
- It can be directly connected to any power amplifier. The best partner is TA-477 120W MOS FET power amplifier.

KIT/ASS. WITH TESTED ..... $55/65
METAL CABINET ..... $18

## NF-CR BI-FET PRE-AMP TA -2800 △△

WITH TREBLE, MID - RANGE AND BASS 3 WAY TONE CONTROL

Match with TA-477 or other main power

Kit
$ 44.50

## 100W DYNAMIC CLASS "A" MAIN POWER AMPLIFIER

TA-1000A △△

OVER 5000's SOLD!

KIT ..... $ 51.95
METAL CABINET/X'FORMER ..... $26/$16.80

We've rated our goods with a △indicating the level of difficulty for kit assembly:
△ beginner level; △△ intermediate level;
△△△ advanced level;
A indicates the product has already been assembled.

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## 300W HQ HI-FI POWER AMPLIFIER (MONO) TA-3600 △△△

QUASI-COMPLEMENTARY-SYMMETRY WITH PARALLEL HIGH OUTPUT TRANSISTORS'
SPECIFICATIONS:
*POWER OUTPUT: 300W (RMS) INTO 8 OHMS
2450W (P.M.P.O.) INTO 8 OHMS
540W (MUSIC POWER) INTO 8 OHMS
*LOAD IMPEDANCE: 4 OHMS OR 8 OHMS
*FREQUENCY RESPONSE : 10Hz-200,000Hz
*TOTAL HARMONIC DISTORTION LESS THAN 0.05%
*INPUT SENSITIVITY AND IMPEDANCE AT 1KHz 1V-1.4V 47K OHMS
*SUPPLY VOLTAGE: DC ± 75V OR AC 53V x 2 8A
KIT/ASSM.WITH TESTED .....$80/92
X'FORMER .....$30.00

NEW FOR 1988

## ELECTRONIC ECHO AND REVERBERATION AMPLIFIER ☆

TA-2400A

REMIX RECORDS W/ ECHO EFFECT YOURSELF !

Ass. with tested ..... $ 99.85

## 4½ HI-PRECISION D.P.M. (WITH DIN STANDARD ABS CASE) SM-48A △△△

NEW

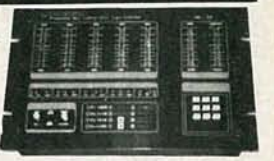
SM-48A Digital Panel Meter employs a high-quality analog-digital converter (ADC) as its main device and employs 0.55" high LED display as 4½ digit display. The required external components of SM-48A are very little.
SPECIFICATIONS:
*4½ digit 14mm red large display with overload flash.
*Multi-functions: including BCD, BUSY, STROBE output, very suitable for micro computer.
*MEMORY STYSTEM CAN HOLD the input reading for comparison and monitor.
*Range: DC voltage DC±1mV-±2000A
DC current DC±1uA-±20A
*Accuracy: DC±0.025% ± 2 digit
*Power: DC5-6V at 200mA
DIMENSIONS: 3 3/4" (W) x 1 7/8" (H) x 4 1/16" (D). (MEET WITH DIN, STANDARD OF W. GERMANY.)
KIT/ASSM. WITH TESTED .....$41/51

## BOW + 80W DC LOW TIM PRE-MAIN POWER AMPLIFIER △△

BUILD A 160 W HI-FI STEREO AMP — YOURSELF —

KIT .....$55.38
METAL CABINET/X'FORMER .....$26/$16.80

## PROFESSIONAL COLOR LIGHT CONTROLLER SM—328 ☆



FEATURES
1 FOUR GROUPS OF INDEPENDENT OUTPUT SYSTEM 1000W/CH MAX 4680W (100-117V) 2 PROFESSIONAL COLOR CONTROL SYSTEM (KEY BOARD TYPE) 3 INDEPENDENT INPUT SIGNAL ADJUSTMENT 4 FOUR GROUPS OF INDEPENDENT DIMMER CONTROL 5 SPEED CONTROL CHASER 6 AUTOMATIC CHASING CONTROL SYSTEM 7 FOUR KINDS OF SPECIAL CHASING PROGRAM 8 COMBINATION OF PROGRAM AND MUSIC CHASING EFFECT 9 FORWARD/ BACKWARD CHASING CONTROL SM-328 color light controller is specialized for ballroom, night club disco and advertisement lighting. It consorts with several color control charact eristics, which employ professional color control system and keyboard program selection. Therefore, it is capable of producing lighting effects by using chasing program and fluctuating music signal. There are two kinds of lighting effects. The first type is controlled by 'music' signal. In order to adjust the brightness of four groups of lightings, each music signal will be separated into high, medium low A, and low B frequency range. Furthermore, each group of lightings is incorporated with an independent signal adjustment. The second kind is composed of electrical circuits and this is the main part for creating a special lighting effect. It has four chasing programme.
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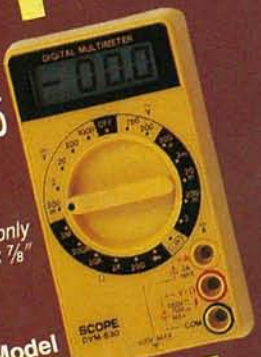

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